

CIVIC SCIENCE
IN HOME AND COMMUNITY

HUNTER AND WHITMAN

put is a reaction

Color is the difference in speed of a
light ray.

Corena Art.

Arnold
Kansas

$n = \frac{c}{v}$

$\frac{1}{2} \phi$

412

Quintin

Amperage is the amount of
electricity.

Rocks

Melted rock - partly liquefied.

Sandstone

limestone.

Marble

granite

3 classes of rock

Sedimentary -

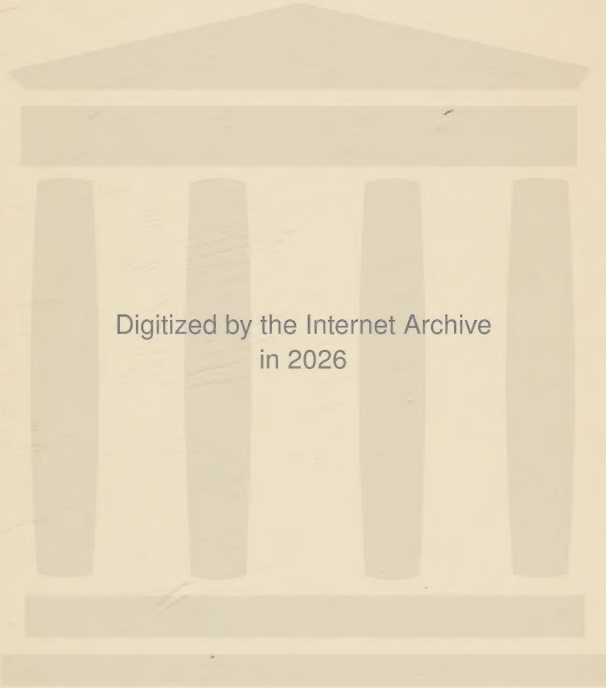
Melted

stratified - layers.

Metamorphic

Solution.

~~Chemical elements~~



Digitized by the Internet Archive
in 2026



Home and Community

CIVIC SCIENCE

IN HOME AND COMMUNITY

BY

GEORGE W. HUNTER, PH.D.

PROFESSOR OF BIOLOGY, KNOX COLLEGE, GALESBURG, ILLINOIS
FORMERLY HEAD OF DEPARTMENT OF BIOLOGY, DEWITT
CLINTON HIGH SCHOOL, NEW YORK

AND

WALTER G. WHITMAN, A.M.

EDITOR, GENERAL SCIENCE QUARTERLY
PHYSICAL SCIENCE DEPARTMENT, STATE NORMAL SCHOOL
SALEM, MASSACHUSETTS



AMERICAN BOOK COMPANY

NEW YORK

CINCINNATI

CHICAGO

BOSTON

ATLANTA

COPYRIGHT, 1923, BY
AMERICAN BOOK COMPANY

All rights reserved

H.-W. CIV. SCI.—HOME-COMMUNITY

E. P. 13

MADE IN U. S. A.

FOREWORD TO THE TEACHER

Man's place in relation to science. — Living things, man included, live in an environment which is made up of certain definite factors, and with these factors living things react and interact. Some of these factors are materials — things; other factors are forces. The ultimate result of the complex we call life is the interaction of the materials and forces with the living things on the earth. Man, however, is supreme among animals because he alone can control the factors of his environment. He has control of fire and water and electricity. From the cave of primitive man the complex housing systems of the present age have developed. The communal life has brought with it new problems — the disposal of wastes, the safeguarding of water and milk supplies, and all the requirements of community sanitation and hygiene. Man's higher civilization demands use of machines, the need of which his forefathers neither knew nor felt, the means of transportation and communication, and an opportunity for a more varied and practical education.

Children's interests in science. — In the midst of a world of new opportunities and scientific progress our children are growing up. Science beckons to them from every side and speaks in each new device used at home for comfort and efficiency. The telephone and telegraph, the trolley and the automobile, the airplane and the submarine, have all become part and parcel of their daily lives.

In any scheme of modern education we must take individual differences into consideration. We no longer educate in the mass. Sex, age, environment, capability, heredity, are all important factors which must be recognized by the modern teacher as having a place in educational practice as well as theory.

The project method. — Since we must allow for individual differences in our scheme of education, it goes without saying that mass education, which does not consider the child as a personality, can no longer be admitted as a part of our scheme. We must take cognizance that the factors mentioned in the last paragraph — environment, age, and sex — act more uniformly and thus may be taken into account in the forming of classes or groups. But individual capability and endowments, heredity's part in the game of life, are much more difficult factors with which to deal. Recent developments in educational psychology show that one method of attack, however, has certain elements which may be used successfully with any group of children not too young to think to a conclusion. Problem solving of one sort or another is common to all the activities of life. Ability in this line is the one great factor which determines success or failure in life.

Methods in science adapted for children. — We hear a good deal nowadays about the logical versus the psychological approach. No teacher, and the word is used in its truest sense, can succeed without the viewpoint of the child. Approached from this angle, the psychological becomes the logical. We must have a plan, but we must remember that a plan may sometimes be changed to advantage. Above all we must be human. If we but remember how we looked at things with the eyes of thirteen

instead of those of forty-three we will have no difficulty in developing a method of attack for the lesson. We must remember, too, that concepts *grow* and are not always brought to maturity in one lesson. The cyclic treatment of topics, which has been followed in Civic Science, is a far more natural method of acquiring information than a dogmatic statement, made perhaps with proof but dimly comprehended and soon forgotten.

The textbook in introductory science. — Any book in introductory science should be based on the facts we have just mentioned. It must contain an adequate amount of the basic material from which the interpretation of the common things of interest in life may be gained, and it must also be adapted to start the individual boy or girl whose interest has been awakened along the line of the project in which this developing interest would naturally flow. Most of all a textbook should interpret to the child the part played by the various natural factors in the environment. It should conceive the child as a center, with all the world revolving around it. In this conception boys and girls become aware of the vital parts played by air, water, light, heat, and food on them as individuals within their homes. These are common to all — the application of some of the general facts learned can be carried out as special projects by various pupils who are interested. After the child has learned the meaning of these central factors in the home, the next step would be logically the application of the forces of nature by man in communal life.

Use of experimental work. — Reference is made throughout the book to three types of experiments: demonstrations, home projects and laboratory experiments. A

number of demonstration experiments are included in the text. Projects, home and laboratory experiments are worked out more fully in the loose-leaf manual. Reference to these experiments is made at those points where experience has shown them to be of the most value.

Acknowledgments. — For an incentive to undertake this work, the authors are indebted to those educators who have written much on the subject of science for young people, particularly, Thomas M. Balliet, Thomas H. Briggs, John Dewey, Charles W. Eliot, David Snedden, George R. Twiss, and John F. Woodhull. To the many science teachers who have been active in developing general science from its early beginnings to its present state, the authors make full acknowledgment for help and inspiration. The following teachers have carefully read much of the proof and made many valuable suggestions: Mr. M. C. Leonard, Vice-principal, Dickinson High School, Jersey City; Miss A. P. Hazen, Head of the Department of Biology, Eastern District High School, Brooklyn; and Mr. George C. Wood, Head of the Department of Biology, Commercial High School, Brooklyn.

REFERENCE BOOKS

- Dewey, *How We Think*, especially Chapters IV, V, VI, and XV. D. C. Heath Company.
- Eikenberry, *The Teaching of General Science*. University of Chicago Press.
- Flexner, *A Modern School*, *New York Occasional Papers No. 3*. General Educational Board, New York.
- Hunter, *Laboratory Problems in Civic Biology*, Foreword. American Book Company.
- Huxley, *Physiography*. D. Appleton Company.
- Trafton, *The Teaching of Science in the Elementary School*, especially Chapter V. Houghton Mifflin Company.
- Twiss, *Science Teaching*, especially Chapters II, III, IV, and XIX. The Macmillan Company.
- Woodhull, *The Teaching of Science*. The Macmillan Company.

TABLE OF CONTENTS

CHAPTER	PAGE
FOREWORD TO TEACHERS	5

SECTION I.—HOME SCIENCE

PART I. SCIENCE AND THE HOME

I. Why we study science	11
II. The home and its environment	23

PART II. GOOD HEALTH IN THE HOME

III. The air and how we use it	43
IV. Water in the home	62
V. Food in the home	76
VI. How wastes are removed from the home	97
VII. Germ dangers and health habits	109

PART III. HEAT IN THE HOME

VIII. Fuels and heat	123
IX. Heating our homes	136
X. Fire prevention in the home	149

PART IV. LIGHT IN THE HOME

XI. Light for home use	162
XII. Importance of our eyes	174

PART V. HELPFUL HOME EQUIPMENT

XIII. Simple machines used in the home	185
XIV. Electricity in the home	197

PART VI. RECREATION

XV. Recreation at home	217
----------------------------------	-----

SECTION II.—COMMUNITY SCIENCE

PART VII. ADVANTAGES OFFERED BY THE COMMUNITY

CHAPTER	PAGE
XVI. The ideal community	243
XVII. How the community came into existence	259

PART VIII. WEATHER AND CLIMATIC CONDITIONS

XVIII. The effect of climate on community life	275
--	-----

PART IX. WATER AND ITS PLACE IN THE LIFE OF THE COMMUNITY

XIX. Water and its relation to community welfare	295
XX. The community water supply	317

PART X. HOW THE COMMUNITY CARES FOR ITS CITIZENS

XXI. How the community provides for proper food	331
XXII. How the community fights disease	347
XXIII. Street lighting	370
XXIV. How the community protects and educates its citizens	385

PART XI. TRANSPORTATION AND COMMUNICATION

XXV. Development of land transportation	408
XXVI. The automobile and gas engine	424
XXVII. Transportation by water	437
XXVIII. Transportation through air	449
XXIX. Means of communication	462

PART XII. THE DEVELOPMENT AND PROGRESS OF LIVING THINGS

XXX. Gardens and their place in the community	480
XXXI. Improvement of life on the earth	499

*Sciences are mechanical helps
for making life easier.*

SECTION I. HOME SCIENCE

PART I. SCIENCE AND THE HOME

CHAPTER I

WHY WE STUDY SCIENCE

- Problems.** — 1. *Why is a knowledge of science essential?*
2. *Why is the "method of science" important?*
3. *What is a science project?*

Experiment. — Why we study science.

Living in an age of science. — Have you ever stopped to think what an important part science plays in your daily life? Many materials found in and around the home in which you live were made by applications of science; the soap you use is made through a knowledge of chemical processes, most of our foods have been prepared by scientific methods and cooked on stoves made by machines. We eat out of machine-made dishes, ride to school in electric cars, trains, or automobiles and go to bed at night in a machine-made bed. And, interestingly enough, many of these scientific devices are of recent origin. Think of the various inventions that have made their appearance during the few years you have lived and you will realize that you are living in an age of science.

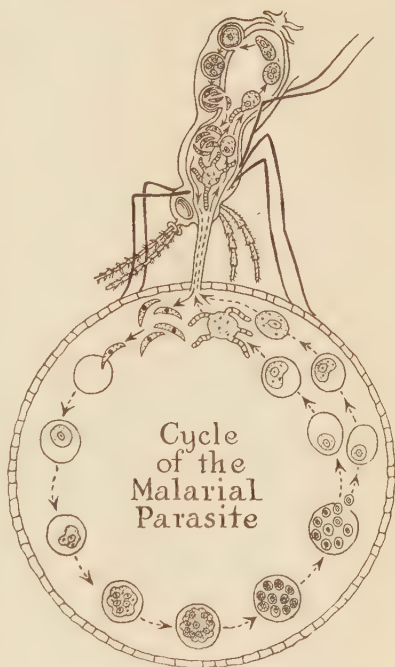
Reasons why we should study science. — Since we live



A triumph of modern science. How many scientific inventions can you think of which are probably utilized in this large office building?

at a time when scientific inventions play such an important part in the world we should be familiar with some of the more common facts and theories which will enable us to use science in everyday life. It is a pleasure and it is to our advantage as well to be able to fix a leaking faucet, to understand why the electric bell does not ring or why the ice-box is not preserving food properly. Training in these lines will help when we are called upon to earn our own living. Opportunities for promotion in many fields of work will be small for those who do not understand common things in science. The practical machinist who applies his knowledge of the principles of science to the working of a machine becomes a foreman in the shop. Then too, our health depends in a large measure upon the discovery of scientific methods for preventing and for the control of diseases — as the next paragraphs show.

An example of how the method of science was used in the discovery of the cause of malaria. — The Italians thought formerly that malaria was caused by bad air, and hence they called it *mal aria*. The way in which it was discovered that this was an error is an interesting story. It was near the end of the last century that a French physician named Laveran found that malaria was caused by a tiny parasite : which lived in the blood corpuscles of man. He reasoned that this was so because he found the tiny animal only in the blood of those suffering from malaria. Later an English army surgeon named Ross, working in India, found after a long series of experiments, that mosquitoes had something to do with malaria. He reasoned that they were blood-sucking insects, that they were always present where malaria was frequent and therefore that they might carry the germ. He worked a long



The life history of the malarial parasite. This cut shows parts of the body of the mosquito and of man. The mosquito injects the crescent-shaped bodies into the blood of man. These enter the blood corpuscles, develop spores which, after being released from the corpuscle, form two kinds of cells. If these two forms of the parasite are sucked with the blood into the body of the mosquito, the other part of the life cycle of the parasite takes place.

period of time before he found that a certain kind of mosquito, called *anopheles*, had some unusually tiny bodies which were full of black specks attached to the inside of its stomach. Ross found later that these black specks were present only after a mosquito sucked blood



The final proof that the mosquito carries malaria.

from a person having malaria. By a process of reasoning and experimentation, he finally came to the conclusion not only that these mosquitoes carried malaria, but also that people could not have malaria unless they were bitten by infected *anopheles* mosquitoes, for a malarial parasite has to live a part of its life in the body of a person

and another part of its life in the body of the mosquito.

The testing of this remarkable theory in Italy came later. A number of people who worked in a malarial region, were persuaded to live in houses which had been carefully screened. As the malarial mosquito flies about only at night practically none of the people who stayed behind their screens at night got malaria, although almost all of their neighbors suffered from the disease.

The final proof came when two physicians, Dr. Manson and Dr. Warren, allowed themselves to be bitten in England by mosquitoes which had been sent from Italy, after having been fed on the blood of a person having malaria. Neither of these men had had malaria previously and the germs could not have been in their system. Eighteen days after they were bitten by the infected mosquitoes, they both came down with the disease. This is an excellent example of how scientific method is applied in the discovery of new facts important to mankind. We now know that all we have to do to escape malaria is to be sure that malarial mosquitoes do not bite us.

A study of the method of science. — A study of the method of science shows us that in solving a problem the first step is taken when the scientist *wants* to know something. He may not know just what to do at once but after thinking it over he decides on a *problem*. The next step is to try to find out some *method* or methods for solving the problem. This is done by thinking over various ways in which it may be attacked. But by the method of *experimentation* he finally reaches a *conclusion*. Thus he solves his problem.

The method of science useful in daily life. — This method of science which we have just described should be applied to ordinary occurrences of the daily life of every educated person. It should become a habit of mind, a way of thinking. Scatter-brained people may think, but their thoughts are not connected and do not lead to a conclusion. We may think when we daydream, but we do not organize our thoughts, nor put them to any use. A great scientist once said that science is “organized common sense,” and such it really is. Nowadays too many

people reason from what they hear and wish to be true. They hear only one side, and do not care to know the other. Bolsheviki are good examples of such people. People who can think straight are the ones who succeed in life. A dangerous attitude of mind results from careless and wrong modes of thinking.

How the method of science is used in thinking straight.— Suppose while we are out walking the sky becomes overcast and we hear thunder in the distance. We may



We observe, we conclude, we verify in the method of science and in everyday life.

want very much to go to our destination and as there is no rain and the clouds do not appear to be very black, we continue our walk. A little farther on, however, we *observe* that the wind is blowing the smoke from a factory chimney toward us and beyond the chimney appear dense black storm clouds. We stop and *reflect* that if the wind is blowing from the direction of the rain clouds it will soon bring them to us. We therefore turn toward home and by rapid walking reach the house just before a deluge of rain falls.

How does this illustrate the use of the scientific method? First we *observe* the dark cloud and remember that rain and wind have accompanied such clouds in the past (*com-*

parison). When we see the smoke blowing from the direction of the storm toward us, we *reason* that the wind will blow the clouds also, and we *conclude* that the storm will soon reach our locality. The storm breaks and we *verify* our conclusion and are thankful that we made shelter in time. If we use this method at all times we shall acquire a habit of mind that will be very useful in later life. It is worth much more than any number of facts that this or any other book can give you.

How we use this method in our school work. — Boys and girls get just as much out of their school work as they put into it. In this course, although the *information* gained cannot help being useful to you in your everyday life, the *method* of doing the work will be of far greater value. To work out home problems or projects with such simple apparatus as is needed to draw conclusions, is far more profitable than memorizing any number of facts. By scientific methods as described above some people make discoveries which are of value to the world.

The project and how it may be worked out. — A project is some piece of practical scientific work that you want to do and that you are willing to work upon because you think it worth while. It may be making a sailboat or an efficient flytrap or an attempt even to clear a town of malarial mosquitoes. *You* are the one to plan your own project and work out the problems connected with it. It will not bring you the best results unless you *want* to know about the thing you are trying to do. Books and people may all help toward the achievement of your project, but *you* must carry it through yourself. Take, for example, a project to determine the best methods of cleaning a room. This would mean investigation on your part of the con-

struction of brooms, wet and dry dust cloths, dustless dusters, carpet sweepers, vacuum cleaners, and of the methods used in performing the work. Not only should the mechanical working of these devices be understood, but also the amount of time and labor spent in cleaning a room with each must be estimated or measured separately. You would be interested to know also how much this time and labor are worth, and the amount should go into your estimate of the value of the different methods. But more important is the knowledge of how much dust is raised and the relative number of bacteria which would be stirred about in the air by each method. To understand this it would be necessary for you not only to know something about the bacteria themselves, but also to perform experiments with a series of prepared culture dishes by which you would determine the relative number of bacteria in the air during each method of cleaning. These culture dishes may be obtained from the board of health, or a good laboratory, or a culture medium made and the dishes filled and sterilized in the school laboratory. Eventually you have a series of facts that enable you to determine which is the best method of cleaning a room. A written report giving all data by which you have reached your conclusions and including interesting facts learned by your study completes your project.

A suggested list of projects follows in order that you may be able to choose one or more in which you will be interested. These projects will be mentioned again in the chapters with which they are connected, and some helpful suggestions for working them out are given in the laboratory manual. But since projects require planning and often a considerable length of time to work out, you

should choose your projects and begin to plan work on them early in the year. In this way you will be ready to report to the class at the right time.

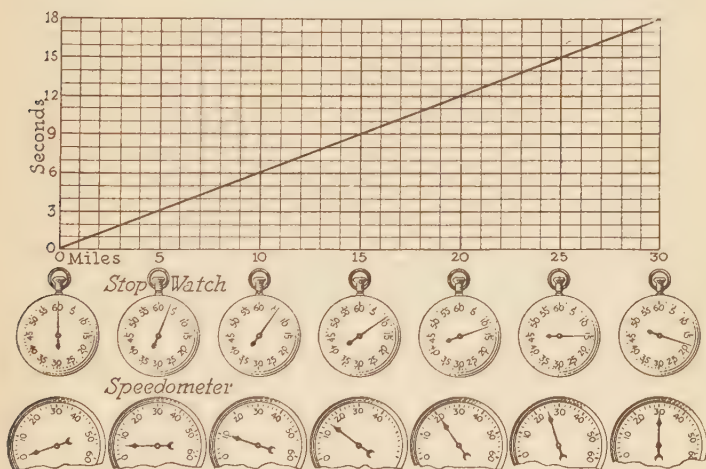
A LIST OF SUGGESTED PROJECTS

1. To learn the advantages of renting and of owning one's house.
2. To plan an ideal house.
3. To become a landscape gardener for your yard or for some friend's yard.
4. To make a home laboratory.
5. To discover and remedy harmful effects of moist air about the house.
6. To learn how to increase the capacity of the lungs.
7. To secure pure air in my bedroom.
8. To prepare for life saving when artificial respiration must be used.
9. To make a lift pump.
10. To see how much water may be wasted by dripping faucets.
11. To find out the nutritive value and cost of foods commonly used in the home.
12. To obtain starch from potatoes.
13. To test and preserve eggs for home use.
14. To pasteurize the home milk supply.
15. To make an iceless refrigerator.
16. To prepare to keep the house plumbing in order.
17. To form correct health habits.
18. To make a house thermometer.
19. To find out of what materials clothes are made.
20. To qualify as an expert heating device operator in the home.
21. To learn how the coal range is constructed and how to run it.
22. To remove the fire hazards from the home.
23. To improve the lighting in the home.
24. To remedy any eye defects.
25. To keep the machines of the home in good working condition.
26. To install an electric bell in the home.
27. To install a night light in a bedroom.

28. To understand the mechanism of the piano and the mechanical piano player.
29. To plan how to utilize the playgrounds of the home lot.
30. To make a study of the advantages and disadvantages of the community.
31. To make a collection of local rocks, minerals and soils.
32. To make a study of the natural resources of a community.
33. To keep a weather record for ten weeks.
34. To make a study of local water power.
35. To make a survey of the needs of the community trees.
36. To investigate and report on the public water supply of the community.
37. To investigate the subject of pure foods in the community.
38. To make a study of the "patent medicine" situation in your community.
39. To try to exterminate flies from the house and community.
40. To make a study of the disposal of waste in the community.
41. To make a survey of street lighting in a section of the community.
42. To study the fire equipment at a nearby fire station.
43. To investigate and report on the roads of the town or city.
44. To make a study of locomotives.
45. To become an efficient automobile caretaker.
46. To become a skilled motor boat operator.
47. To make an aircraft scrapbook.
48. To become a radio expert.
49. To see how plants are improved in the community.
50. To make a study of heredity in your family.

Tools with which we shall work. — A notebook in which to make careful notes of all work done is an essential part of our equipment. We should always take notes of everything we do in connection with our project, both in the laboratory and at home. These notes should be carefully kept, and drawings to illustrate them made, either with a hard pencil or with a drawing pen. We must learn to use

instruments with which to measure and to make diagrams. The use of the metric system is best for all scientific measurements, and a knowledge of the metric tables will be found valuable. One of the most essential things is to learn the value of accurate figures, as this is necessary in the making and understanding of a graph or a diagrammatic representation of a number of figures. An example is seen



The graph represents the speed in miles per hour at the end of successive seconds just as the dials do.

in the diagram, in which is illustrated the relation of time to increase in speed of the automobile. In this particular test it will be observed that for every 3-second period the speed increased 5 miles. A uniform increase like this does not always occur. Suppose the increase in speed for the first 3-second period is 4 miles; for the second 3-second period, 5 miles; for the third, 6 miles, and so on, giving a speed of 4 miles per hour at the end of 3 seconds; 9 miles per hour at the end of 6 seconds; 15 miles per hour at the

end of 9 seconds; 22 miles per hour at the end of 12 seconds, and so on; how would the resulting graph look in comparison with this one? If you do not see how it would appear, work it out on a piece of graph paper for your home notebook.

Last of all, and perhaps most important, we need *enthusiasm* for our work. Success along any line requires attention, thought, and interest. Interest is valuable in school work and failure is often due to indifference. Surely in this great world of science about us, there is enough to interest each one of us.

REFERENCE BOOKS

- Fall, *Science for Beginners*, Chapters I and II. World Book Company.
Hunter, *A Civic Biology*, Chapter I. American Book Company.
Hunter, *Laboratory Problems in Civic Biology*, Chapter I. American Book Company.
Lee, *Health and Disease* (Advanced), Chapter XV. Little, Brown, and Company.
Ritchie, *A Primer of Sanitation*, Chapter XXIV. World Book Company.
Smith and Jewett, *Introduction to the Study of Science*, Chapter XII. The Macmillan Company.
Winslow, *Healthy Living*, Chapter XXIII. Merrill Company.

CHAPTER II

THE HOME AND ITS ENVIRONMENT

Problems. — 1. *To see what our homes do for us.*

2. *To learn how to make the home grounds attractive.*

3. *To find out the chief materials of which our houses are made.*

4. *To see what arrangement and equipment of the important rooms are desirable.*

5. *To learn how to secure efficiency in the work of the home.*

6. *To see what a home can contribute to health.*

Suggested projects. — 1. To learn the relative advantage of renting and of building one's house.

2. To plan an ideal house.

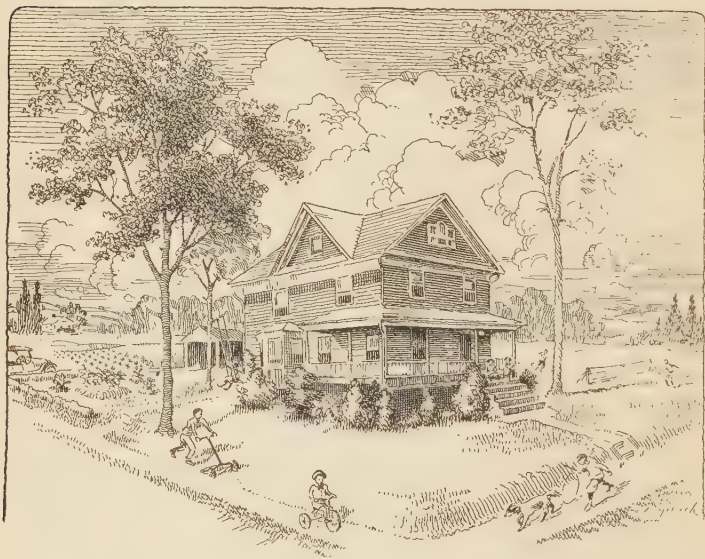
3. To become an amateur landscape gardener.

4. To make a home laboratory.

What is a home? — The term home means more to most of us than a house or an apartment or a furnished room containing our belongings. It is more than a place to live in; it means father, mother, brothers, and sisters; it means family life, with all its give and take, its unselfishness and loyalty to the ideals which father and mother believe to be right.

What home life does for us. — Doubtless each one of us thinks of our home as a place for shelter, for food, and for material comforts of all kinds, but it should be more than this. The home should be the center of a little group in which absolute loyalty is seen instead of selfishness.

At the present time this country of ours suffers much because of the lack of teamwork on the part of the men and the women who share its benefits. Real home life should teach us coöperation and unselfishness, not individualism and selfishness, and we should carry its lessons out into the community and country where we live.



A model home.

The home requirements of civilized man. — Man, if he is to be a healthy individual, should have the following in his home:

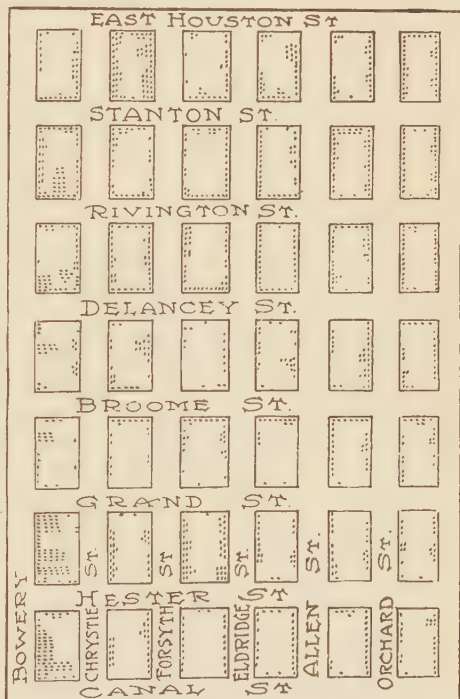
1. Pure air — this means air free from dust and germs, smoke and bad odors.
2. Pure water — free from dirt and germs.
3. Good food, properly cooked, and plenty of it.

4. Moderate heat, both in summer and in winter.
5. Plentiful light, both natural and artificial.
6. Clothing suitable to the time of year.

7. A home well planned, well ventilated, well lighted, with some ground around it for a garden and playground. If the latter is not possible, playgrounds and parks should be provided in the near vicinity.

Some ways to work for an ideal home. — While it is not possible for all of us to live in a home that is ideal, we can do a great deal to improve the conditions under which we live. We do not need to have an

expensive house to have an ideal home but the surroundings must be clean, orderly and sanitary. Crowded conditions, in unsightly and insanitary apartment houses, are not to be compared with the advantages of living in a smaller community, with room to play and work in.



This map shows how cases of tuberculosis recur in the same houses year after year. Each black dot represents one case of tuberculosis. The region is one of the most densely populated regions in New York. Is it a healthful locality in which to live?

Crowding a menace to health.—Although it is not always easy for us to change the place where we live, yet if we realize that crowding in a big city makes a higher death rate, we should be willing to make an effort to move to a less crowded place. The map shown on page twenty-five gives ample proof that some crowded conditions help certain diseases to flourish. Each of the little dots in the picture represents a case of tuberculosis. Notice how numerous the cases are in certain houses. This may



A house without trees or shrubbery.



The home grounds here are well planned.

mean that under the crowded conditions in which these people lived, the disease was more easily transmitted from one person to another. A small one-family house, if one can afford it, is far better than a crowded apartment or tenement.

Planning the grounds.—We have already considered the detached house as the ideal place to live. This is true not only because of the air space around it on all sides, making it cooler in summer and giving good ventilation, but also because of the privacy which comes from living in a house separated from its neighbors. Many cozy and attractive homes are spoiled by the absence of

decorative shade trees, shrubbery, and vines which might easily be grown around them. The first house shown on page twenty-six is a good, substantial one, but it is uninteresting because of its surroundings. Compare it with the next picture. How much more attractive this second house appears, with its well-shaded lawns, its shrubbery, and its flower gardens.

Trees and shrubs not only help to beautify a place but they protect it also from cold winds in winter and from the hot sun in summer. They become the homes of birds, which protect the trees and garden plants from harmful insects. Climbing vines make the house more beautiful and serve as screens to give privacy to a porch.

Planning for profit from the garden. — If we are fortunate enough to have a small yard, we may, even in a city, make it a profitable investment. With a knowledge of some of the principles of scientific gardening such as we shall get in a later chapter it will be possible for us to have vegetables practically all summer and some flowers also.



Climbing vines give privacy.

Where the space is limited, climbing plants may cover the side of the fence. The borders may be filled with plants which mature early, and which may then be pulled up to make room for others.

Planning for pleasure. — Every house lot of reasonable size ought to be planned so that part of it is used for

pleasure. We need out-of-door exercise in the form of games as well as in the form of work. Tether ball, Russian ninepins, volley ball, quoits, or basket ball will give splendid exercise in a limited amount of space, as not over 50

to 200 square feet are needed for any of the above-mentioned games.

We should all remember that the home to be ideal must be a place where we may have a good time, and bring our friends; so that our yards may be the center of a group of pleasant people. How many boys who have read this chapter can make a plan to add in some way to the attractions of their homes, both for themselves and their friends?



Russian ninepins. Ball must go around a post (to the left of picture but not shown here) before it strikes the pins. Score as in bowling.

Building materials. —

If you make a list of all the materials that are used in building a house

you find that wood, stone, glass, concrete, and metals are among the most important. Wood is still one of the most common building materials in this country. The quality of the wood depends on the kind of tree which produced it, and the beautiful grain that is visible in some woods is produced by the so-called annual rings which appear in certain kinds of trees. The material in the board or beam or



Hauling logs.



A granite quarry.

in the molding or mantel of a room is composed of millions of dead cells, of which only the walls remain. These walls are hollow where the living matter has gone, and when the

wood is finished, the holes fill up with paint, oil, wax, varnish, or whatever substance is used to finish the surface.

Stone as building material. — Although not many single houses are built of stone, it makes an excellent building material and is used in those parts of the country where it can be obtained easily. About eighty millions of dollars' worth of stone is used in this country every year. Most of it is limestone, sandstone, or granite. The "life" of a building stone is the length of time before it shows signs of crumbling or chipping. Compare the life of building stones as given in the following table.

STONE	LIFE IN YEARS
Micaceous limestone	2 to 15
Micaceous brownstone (sandstone) . .	15 to 30
Compact brownstone (sandstone) . .	15 to 30
Marble	40 to 80
Fine marble.	50 to 100
Granite	57 to 200

Demonstration. — To make concrete of various mixtures and to compare properties.

Materials: Portland cement. Sand. Steel knitting needles. Frame with six compartments, each about $1\frac{1}{2}$ inches deep, 1 inch wide, and 10 inches long. Mix sand and cement dry, in proportions indicated. Then add water to make a pasty mass which slides easily from the trowel. Make the following mixtures and pour them into the frames:

TEST	CEMENT	SAND
1.	All cement	0
2.	1 part cement	2 parts
3.	1 part cement	4 parts
4.	1 part cement	6 parts
5. ¹	1 part cement	5 parts
6. ²	1 part cement	6 parts

¹ Reinforce by putting in five steel knitting needles well spaced.

² Instead of using sand use dark earth or loam.

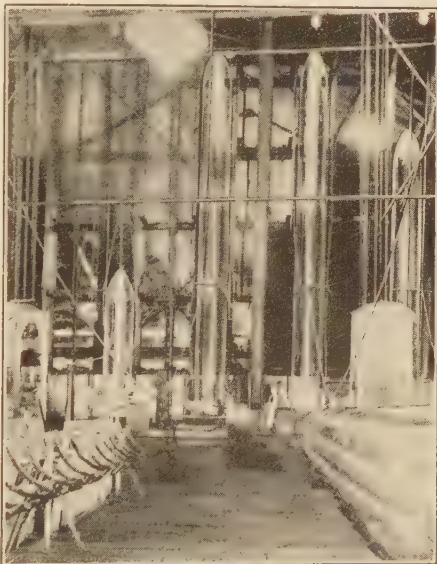
Let the mixtures harden from three to four weeks. Examine for appearance. Test for strength. If supported at the ends, how much weight across can be supported? Conclusions?

Artificial stone. — Cement, hollow tile, and concrete are used more and more in the construction of houses. Some of the most beautiful, as well as economical, small houses are made now of concrete or hollow tile, with a coating of stucco, a kind of plaster placed over the outside of the house. These different kinds of stone have the advantage over wood, of giving protection against fire.

Brick houses. — Brick houses also are very common in cities and in localities where clay is abundant. Bricks, as most of us know,

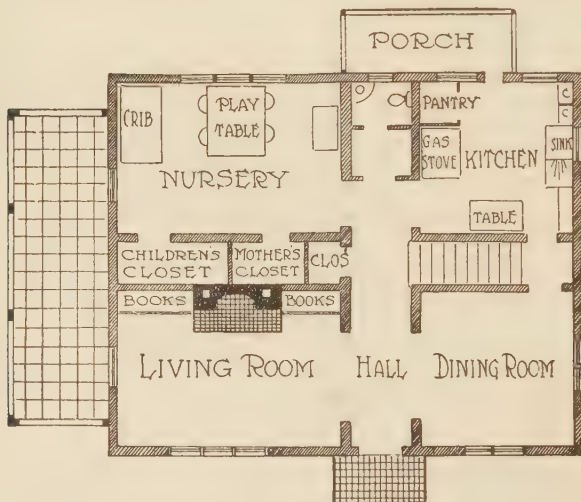
are made from wet clay which is ground, placed in molds and then baked. By various processes, a glaze is put on the outside of some of the bricks, which renders them more or less waterproof.

Glass in the home. — We do not always think of glass as a building material, yet it is a very important one, as there is no satisfactory substitute for it. In these days of



Making window glass.

sun parlors, large windows, and enclosed porches, glass is used more and more extensively. Window glass is manufactured out of sand mixed with lime and compounds of sodium, melted at a high temperature, and then blown by machinery into great cylinders which are cut and placed



In what respects is this a good first floor plan? Has it any defects?
(After Van Rensselaer.)

in furnaces, flattened out, smoothed off, and finally cut into sizes used by the trade.

A well-planned house. — We may not be able to own the house in which we live, still, since we are considering ideal conditions, we should think about house planning. A study of the accompanying diagram will show us a small house which is well arranged. Which rooms are necessary? Which could be dispensed with?

Color in the home. — How many times have you gone into a home where the strange combination of colors of the

wood, wall paper, and hangings offended the eyes! How pleasant it is to go into a home in which the paper, wood-work, and furnishings blend, giving a feeling of comfort and home-like warmth! One reason why some rooms are dark is that a large amount of light is absorbed by the dark walls. A yellow or light-colored paper on the walls would reflect the light and make the rooms much more attractive. Light colors increase the apparent size of a room also and



Which wall paper makes the more pleasing background?



Name the good points of this bedroom.

give it the effect of cleanliness and good cheer. Dark colors make a room seem smaller, and while they produce an effect of dignity and richness, very often they make a room look gloomy, and difficult to light. Wall papers

are more restful and better for the eyes if used in plain colors, such as tans, buffs, blues, and reds.

The ideal bedroom. — Did you ever think that you spend about a third of your life in your bedroom? Since this is so, a bedroom is a very important place and we

should treat it as such. As pure and sufficient air is essential the bedroom should have at least one large window, and if possible, two. At night, winter as well as summer, the window should be open, both top and bottom, so that a current of pure and fresh air may come to us while we sleep. The furnishings, even for the girl who



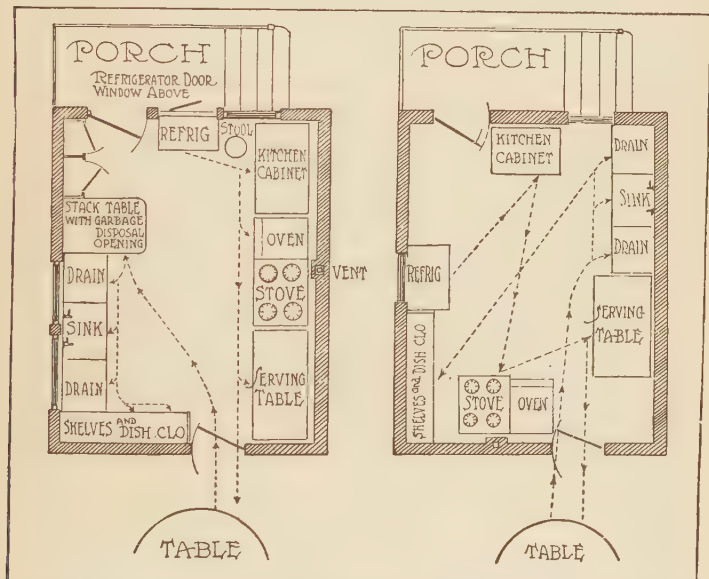
Why is this an ideal living room?

likes pretty things, should be plain and simple with only a few hangings and rugs, as they collect dust and dirt. It is better to have the walls painted than papered, especially in a rented house. A painted iron bedstead, with movable springs and a moderately hard mattress, is the best bed for young and growing boys and girls.

The living room. — A living room can be made attractive and homelike with a big table, plenty of books, a well-placed central light around which the family may

gather in the evening, and a few good pictures and hangings on the walls.

The ideal dining room. — The dining room should be bright and sunny with the furniture comfortable and home-like. The table should be large enough for all of the family



Saving steps in the kitchen. Which arrangement do you prefer? (After Frederick.)

to have plenty of space, and laid with good, clean dishes and glassware. Remember that cleanliness of dishes, cooking utensils, and food will go a long way in preventing disease, especially during hot weather.

The kitchen. — Since so much work is done in the kitchen it is really one of the most important rooms in the house. It requires a good gas or coal range, a fireless cooker, for use in hot weather especially, exposed plumb-

ing, a large sink and stationary washtubs. There should be plenty of shelf room, several closets, one for pots and pans, another for storing dry food of various kinds, and a cupboard with glass doors for the keeping of glasses and dishes. The icebox should not be in the kitchen, but in a passageway which leads outside, and must be kept immaculately clean.

The bathroom. — The bathroom, though a small room, is surely very important also. It has been said that "Cleanliness is next to godliness"; certainly cleanliness is necessary for health. The bathroom should have painted or tiled walls which can be cleaned easily. The floor should be tiled or covered with linoleum, and all equipment, including the bathtub, toilet, bowl, and seat, made of white enamelware, so that they may be cleaned thoroughly. There should be ample provision for soap, clean towels, bath sponge, hot and cold water, and, if possible, there should be a shower bath. A medicine chest of white enamelware with glass shelves completes the equipment of the room.

Cellar and heating plant. — Our ideal home has a cellar in which there is storage room for vegetables, canned goods, wood, and coal. The heating plant should be of ample size to heat the house in the severest weather. Methods of heating the house will be discussed in a later chapter.

Efficiency in the home. — Nowadays we frequently hear the word "efficiency." We have efficiency engineers in great manufacturing plants to see that the most is made of the machinery, and the time of the workmen. Why should not each one of us be an efficiency engineer in our own home? We could all train ourselves to discover where there is wasted energy, and study how to prevent it. In

factories, machines have largely replaced hand labor. The machines last only a few years, and are then replaced by others which can do the work better. Why not apply this business principle of efficiency to our homes? It would mean more time for recreation, reading, and social life. The reduction of housework and the use of sanitary conveniences would assist in making the health of the family better. How is it in your home? Could a few dollars be well spent for equipment which would make your mother's work easier? Why not study the situation as a home project?

The habit of work. — The great inventor, Edison, in his seventies, is able to work long hours



Thomas Edison, one of our greatest inventors.

day after day. It was his habit to work, even when he was a small boy. We find that most men and women who have developed into leaders accustomed themselves to work when they were young. Learn to accept your share of the home duties, and you will develop a sense of responsibility and habits of industry which will be of the greatest value later in life. Learn to do home tasks willingly, for thus you will develop unselfishness. The efficiency of a household is lowered by every idle member in it. Learn now to be a helper, and some day you will assume more easily the responsibilities which will come to you when you are grown up.

Recreation in the home. — It is an old saying that all work and no play makes Jack a dull boy. All work is wrong, and all play is wrong, but play is just as important



This boy, as a result of exercise, fresh air, and nourishing food, has a strong healthy body. He is able to take care of himself. (After Davison.)

as work for normal boys and girls. Recreation means *recreation*, for we are really made over by doing interesting things which rest our body and mind. Reading, music, visiting friends, playing games, are all good types either of indoor recreation or outdoor exercise and are absolutely necessary for a growing boy and girl. Our lungs and muscles need developing as well as our brains.

You must obey health rules. — Daily following the rules of good health will do

more than anything else to make your life a happy and a helpful one. Did you ever think what it would mean not to be able to run a foot race, or make a high jump, or play a game of tennis or baseball? Without attention to the rules of right living, proper eating, drinking, breathing, and care of your bodily organs, even the strongest of you may become weak. You may be in the best of health now, but if you are not willing to give proper care to your body, you may pay the cost later. Do not think you cheat someone else by not brushing your teeth, or not wearing the warm clothes that your mother suggested, or by read-

ing too long in a poor light, for you cheat only yourself. Be faithful in your health habits; it pays in the long run.

Scoring the home. — Emerson has said that we must “hitch our wagon to a star,” which means really that we must have high ideals in life. In order to estimate your own homes in the light of the chapter you are now reading, a score card follows which every pupil should study, and attempt to score his own home. Try to be honest in your scoring, and remember that although your score may seem low, nobody’s score will be perfect, because we have “hitched our wagon to a star.” This project will be a preliminary survey of our homes, and in a later chapter we shall make a more careful study of each of the headings in this score card. You will notice that this first score card has three columns headed respectively “Perfect score,” “My first (guess) score” and “My final (real) score.” This means that you are to make a record of this score card as a preliminary exercise for your notebook. In the second column place the score you think you ought to have, after having first consulted the score cards you are referred to at the ends of certain of the chapters. The scores should be totaled and a grand total obtained. The third column marked “My final (real) score” will be filled little by little as you study the future chapters. You will probably find that your first estimate was far too high and thus the third column will serve to check up on your “guess” or first estimate. This shows a use of the scientific method referred to in the first chapter, and will be excellent practice for you.

The score card which is given here is only a suggestion and may be advantageously changed to meet local conditions. Why not undertake as a special project the im-

HOME SCORE CARD

	PERFECT SCORE	MY FIRST (GUESS) SCORE	MY FINAL (REAL) SCORE
1. ENVIRONMENT			
Pure air	10		
Pure water	10		
Well-drained soil	10		
Plenty of sunlight	5		
Not too great extremes of heat or cold	5		
Foods supplied from home garden	5		
Foods cheap and good	5		
2. WATER IN MY HOME			
Safe supply	10		
Ample supply	10		
All parts of home supplied	10		
Plumbing in good condition	10		
Soft water provided	10		
3. FOODS IN MY HOME			
A well-balanced diet	10		
Right diet for occupation and environment	10		
Foods easily digestible	10		
Foods economical	10		
Foods properly prepared and cooked	10		
4. CARE OF FOODS IN MY HOME			
Clean kitchen and utensils	10		
Good refrigeration	10		
Sterilization and pasteurization	10		
Proper use of preservatives	10		
Protection from insects, etc.	10		
5. HOUSEHOLD PESTS			
No flies	10		
No mosquitoes	10		
No body pests (fleas, bedbugs, head lice)	10		
No food or cloth pests (roaches, ants, weevils, clothes moths, etc.)	10		
No rats or mice	10		
6. REMOVAL OF WASTES			
Exposed plumbing	10		
All porcelain fixtures	10		
Have a working knowledge of system	10		
Sewer connections or septic tank	10		
Garbage pail properly kept	10		
7. PERSONAL HEALTH HABITS			
(See page 121)	100		
PROTECTION AGAINST DISEASE			
(See page 122)	50		
8. FUELS			
Warmth obtained	10		
Ventilation and protection against loss of heat	10		
Economy of fuel	10		
Economy in time and work in attending to heating plant	10		
Efficiency of cooking stove	10		

HOME SCORE CARD

	PERFECT SCORE	MY FIRST (GUESS) SCORE	MY FINAL (REAL) SCORE
9. CLOTHING, BATHING, AND VENTILATION			
Proper outer clothing	10		
Proper and clean underclothing	10		
Bathing	10		
Proper bedroom hygiene	10		
Proper home ventilation	10		
10. LIGHTING MY HOME			
Sunlight plentiful	10		
Windows ample, wall papers good reflectors	10		
Artificial light economical	10		
Proper lighting for all kinds of work	10		
Good systems of lighting used.	10		
11. PROPER CARE OF MY EYES			
See page 183, for items.	50		
12. MY HOUSE			
Detached house	10		
Home owned, not rented	10		
Bedrooms and comfortable living room.	10		
Suitable dining room.	10		
Convenient kitchen	10		
Bathroom, hot and cold water	10		
Heating plant adequate	10		
Cellar with cold closet	10		
House new	10		
House in good repair.	10		
13. THE HOME GROUNDS OR PARKS, PLAY- GROUNDS, AND LIBRARY			
(See Chapter 24)	50		
14. MY HOME GARDEN			
General appearance	10		
Choice of vegetables	10		
Freedom from pests	10		
Evidence of planning	5		
Care of tools	5		
Value of produce	10		
15. DEVICES FOR CONVENIENCE AND LABOR SAV- ING IN MY HOME			
Electric and gas devices	15		
Cleaning helps	10		
Kitchen helps.	10		
Other helps: sewing machine, telephone, etc.	10		
Tools and work room	5		
16. MY INDOOR RECREATIONS			
Score based on points mentioned in Chapter XV. See Score Card, page 240	50		
17. MY OUTDOOR RECREATIONS			
Score based on points mentioned in Chapter XV. See Score Card, page 241	50		
GRAND TOTAL	1000		

provement of the series of score cards, with addition to or subtraction from this list?

REFERENCE BOOKS

- Allen, *Civics and Health* (Advanced). Ginn and Company.
- Child, *The Efficient Kitchen* (For teachers). McBride, Nast and Company.
- Clark, *The Care of a Home* (For teachers). The Macmillan Company.
- Clark, *An Introduction to Science*, Chapters XVIII. XXIX. American Book Company.
- Conn, *Bacteria, Yeasts, and Molds of the Home*. Ginn and Company.
- Davison, *Human Body and Health*. American Book Company.
- Farmers' Bulletin 401, U. S. Dept. Agr. *The Use of Concrete on the Farm*.
- Farmers' Bulletin 474, U. S. Dept. Agr. *The Use of Paint on the Farm*.
- Frederick, Mrs. C., *Household Engineering*. American School of Household Economics, Chicago.
- Hunter, *A Civic Biology*. American Book Company.
- Hunter, *Laboratory Problems in Civic Biology*. American Book Company.
- Jewett, *Town and City*. Ginn and Company.
- Morris, *Household Science and Arts*. American Book Company.
- Portland Cement Association, *Booklets 20, 120, 135, 140*. 111 West Washington St., Chicago.
- Standards, Bureau of, *Bulletin 70*.
- Tolman, *Hygiene for the Worker*. American Book Company.
- Van Rensselaer, *Manual of Home Making* (For teachers and project reading). The Macmillan Company.

PART II. GOOD HEALTH IN THE HOME

CHAPTER III

THE AIR AND HOW WE USE IT

Problems. — 1. *To learn what air is.*

2. *To understand how and why we breathe air.*

3. *To understand the need of ventilation and how to ventilate.*

Suggested projects. — 5. To discover and remedy any harmful effects of air about the house premises.

6. *Can I increase my lung capacity within ten weeks?*

7. *How to secure pure air in my bedroom.*

8. *To prepare for life saving, using artificial respiration.*

What is environment? — Have you ever tried to reduce the materials which are necessary to us in our life on the earth to the lowest possible number? You will find that they are air, water, food, heat, light, soil and certain living things. We call these various things the *factors* of our environment.

Experiment. — To show that air occupies space.

Living in an ocean of air. — Air, one of these necessary factors, surrounds us all the time and we live as it were at the bottom of an ocean of air. Although we are usually unconscious of it, we know it is around us for when the

periments may help us to find out. If we cover a burning candle with a glass tumbler we notice that the flame goes out in a short time. If we uncover the candle and light it again it will burn. If we cover it again, the flame goes out as before. It is evident that some change takes place in the air in the glass which causes the burning of the candle to cease. Perhaps there is something in the air necessary for the burning which is quickly decreased when we limit the supply of air by enclosing the burning candle in the tumbler.

We are told by men who have analyzed air that about 99 per cent of it is made up of two gases, oxygen and nitrogen. There are also small amounts of carbon dioxide and water vapor besides other gases and dust in the air. If we prepare oxygen and nitrogen and study their properties separately, it may help us to explain the part that the air plays in burning matter and in supporting life and also to show us whether it is the oxygen or the nitrogen which is used in these processes.

What makes the candle burn? — If we place a lighted candle in a jar, it burns a short time and goes out. Put another burning candle in this same jar and it goes out immediately. Evidently the part of the air which caused the first candle to burn is not present when the second candle is placed in the jar. Let us try to find out if the missing gas is oxygen. In our experiment we saw that a candle burns in oxygen and we guess that it is oxygen that makes it possible for the candle or splinter to burn in the air. Suppose we introduce some oxygen into the jar in which the candle did not burn and again insert a lighted candle. This time it burns, acting very much as it does in the open air, showing that the addition of oxygen to the

gases in the jar was necessary to allow the candle to burn. The process of burning is called *combustion*.

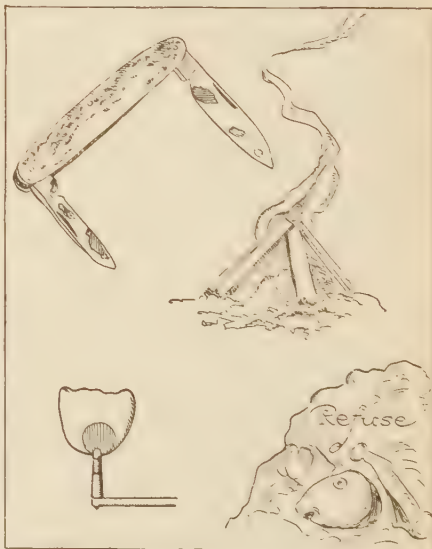


The limewater test for carbon dioxide.

limewater in a jar after burning wood or a candle in it, we get the same result as before, the limewater turns milky. Evidently we might use this limewater test to find if this same gas is present in the air when certain things are

burned. The chemist tells us that he uses limewater to test for the presence of carbon dioxide and that carbon

Still another gas in the air. — If we were to leave a jar containing limewater open overnight, we would find a whitish film on the surface of the liquid in the morning. If we prepare a gas by pouring a little vinegar or hydrochloric acid upon cooking soda and pass it through limewater, the liquid becomes milky in appearance. If we shake a little



What kinds of oxidation are shown here?

dioxide is formed by the union of oxygen and an element called carbon, when anything containing carbon is burned. Carbon dioxide is always present in the air, although in very small amounts, about .04 per cent in out-of-door air. It is being given off into the air constantly by decaying vegetable matter, by burning fuels, and by breathing animals.

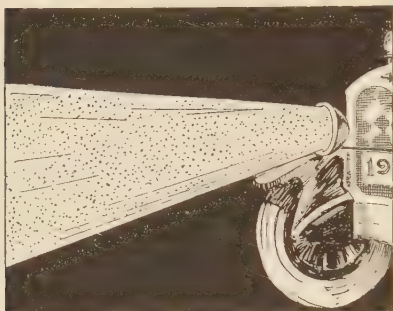
Oxidation. — In the series of experiments we have just performed, combustion was simply a union of oxygen with the carbon which was burned. All around us this union is taking place with other substances but without producing a flame. An example of this is found when iron rusts — or unites with oxygen. *The union of oxygen with another substance is called oxidation.* The rusting of iron is relatively a *slow oxidation*. A similar process attends the decay of organic matter. In the case of combustion the action is much more rapid, and both heat and light result from its action.

Other constituents of air. — Air is really a very complex substance. It contains water vapor which can easily be detected by mixing a little salt with ice in a test tube, and observing the small drops of moisture which form on the outside of the tube. There are several gases beside those already mentioned, found in small quantities in the air; among them is argon. If you allow a beam of sunlight to pass through a small crack into a darkened room, you will see thousands of tiny



This shows that water is present in the air.

specks floating in the air. These are little particles and may consist of soot, dust, germs, or other bodies.

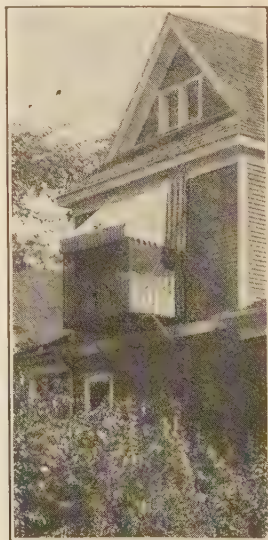


There is dust in practically all the air we breathe.

summer. New laws require city houses and tenements to be built with an adequate air space so that sleeping rooms may have a proper amount of air going in through the windows at night. We have outdoor schoolrooms and both teachers and doctors preach the need of proper ventilation.

It seems almost incredible that over sixty barrels of air pass in and out of your lungs every day of your life. If you will count the number of breaths you take in a minute while you sit quietly in the schoolroom (number of times your chest rises and falls), and then if you will exercise vigorously for two minutes (a stationary run with hands raised above the head

Why is pure air necessary? — This is an age when people recognize the necessity of pure air for healthful living. People build houses with sun parlors open to the air, and with sleeping porches where the entire family may sleep, winter and



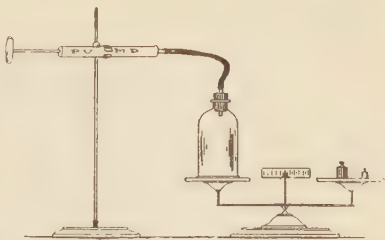
An out-of-door sleeping porch.

will be a good exercise) and again count the number of times you breathe in one minute, you will notice a distinct increase. Evidently the body needs more air when we exercise than when we sit quietly, and this wonderful human machine responds automatically to the demands made upon it.

Demonstration. — Does air have weight?

Materials: A two-liter bottle with one-hole rubber stopper. Glass and rubber tubing. Platform scales. Air pump for suction or compression. Vaseline. Ring stand. Beaker.

Method: Pass the glass tube through the rubber stopper and attach the rubber tube to it. Set the bottle on one arm of the platform scales and fasten the rubber tubing to a clamp on a ring stand, leaving the tubing loose enough to move freely up and down with the movement of the balance. Make the stopper tight with vaseline and tie it in if air is to be forced into the bottle. Balance the bottle exactly by using weights on the other balance arm.



1. By means of a force pump attached to the end of the rubber tube force air into the bottle. Disconnect the pump to open the tube to allow some of the air to escape.

2. By means of a suction pump, draw air out of the bottle. Disconnect pump to let the air back in.

Observations: 1. When air is forced into the bottle what change in weight is observed if any? What results when the excess of air pumped in is allowed to escape?

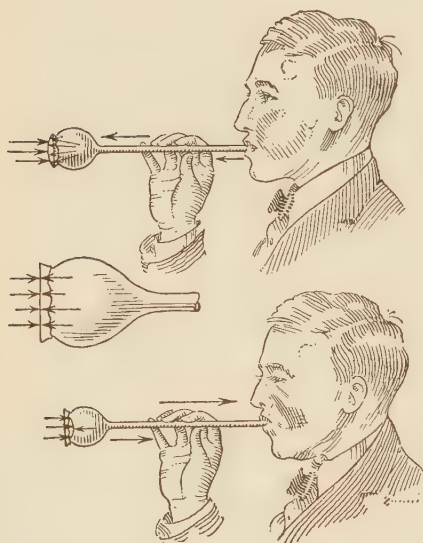
2. When air is withdrawn from the bottle what change in weight is observed if any? What results when the pump is removed and the bottle is opened to the air?

Conclusion: 1. Does air weigh anything?

2. State the evidence by which you reach this conclusion.

Application: Could air exert pressure if it did not possess weight?

Atmospheric pressure. — We are told that air presses down on us with a force of fifteen pounds to the square inch. The effect of atmospheric pressure is seen if the air is sucked out of a space which has one side separated from the atmosphere only by a sheet of rubber. At first



the pressure on both sides of the rubber is the same because both sides are open to the atmosphere and the rubber is straight. But when we remove the air from one side by suction we reduce the pressure on that side and the greater atmospheric pressure on the outside is disclosed by its pushing the rubber in, as shown by the illustration. It is easy to

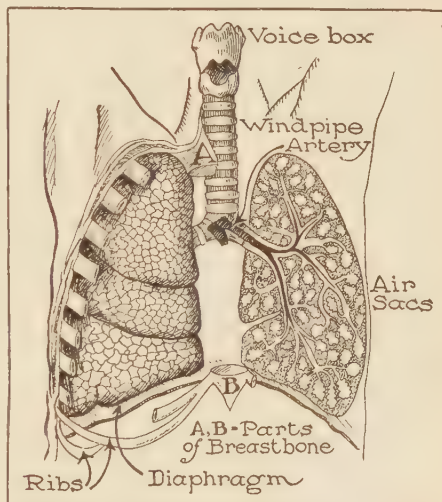
understand that water exerts pressure on a vessel which contains it, but it is more difficult to think of air as having weight and hence exerting pressure. We may determine by an experiment whether or not air has weight by weighing a bottle before and after pumping air out of it.

Air pressure. — By blowing into the tube we can put more air into it and it will push the rubber out more than the atmosphere does, as shown in the illustration. Air enclosed under pressure is very useful in automobile

tires, door checks, air brakes, air rifles, and enclosed under high pressure it is used to drive machines used in drilling and for a sand blast.

How we breathe. — We all know that somewhere inside of our bodies there are spongy organs called lungs. The diagrams (page 58 and below) show us that from the mouth cavity down the front of the neck leads a tube known as the air tube, or *windpipe*, and that this tube branches into two pipes, or *bronchial tubes*, which in turn divide again and again and end in tiny grapelike clusters of little air sacs, which are too small to be seen with the naked eye. In these air

sacs, which have extremely thin walls, the oxygen of the air comes in close contact with the blood, the blood taking some oxygen and giving up in return some carbon dioxide, which has been brought here from the various parts of the body where work is being done. Around these delicate lungs are the *ribs*, so that as the diagram shows, the two lungs are held within a sort of bag or cavity. This chest cavity is bounded at the bottom by a muscular wall, the *diaphragm*, which extends across from

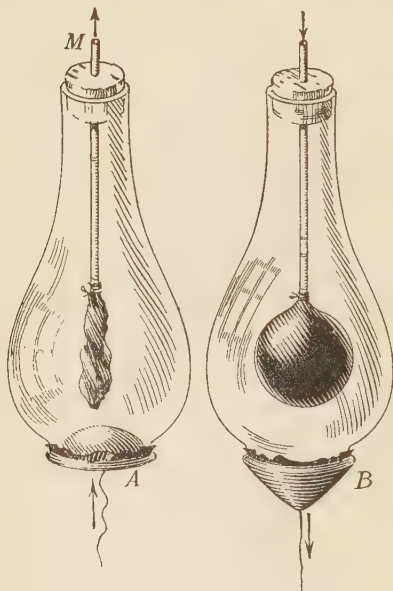


The human breathing organs. Notice one lung is cut open to show the air sacs.

the front to the back of the body, and makes an air-tight surface beneath the lungs.

Demonstration. — To illustrate the process of breathing.

Materials: A lamp chimney is fitted with a rubber cork, through which has been placed a glass tube having a rubber balloon tied to the lower end. Over the open end of the lamp chimney is tied a piece of sheet rubber such as dentists use, with a piece of string attached to the middle on the outside.



Method: Pull on the string so that the cavity inside the lamp chimney is increased in size. Allow the rubber to go back to its former position by releasing the pull on the string. Cover the open tube *M* with the finger and pull the rubber down as before.

Observations: 1. What happens to the rubber balloon when the rubber is pulled down?

2. What happens to the rubber balloon when the

rubber is released? When pushed in?

3. What difference in action is observed when the tube *M* is closed?

Conclusion: Explain the part atmospheric pressure plays in the movements observed here.

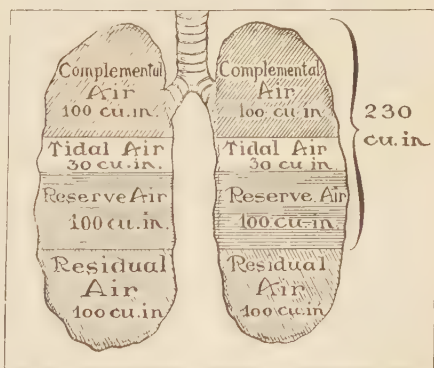
Application: Apply the movements you have seen here to those in breathing. What represents the lungs? What the diaphragm? Just what part in breathing does the atmospheric pressure play?

If you will stand upright and take a full deep breath, you will readily notice that when the breastbone is lifted

the ribs also are raised. At the same time the muscular diaphragm assumes a straighter line. This makes the chest cavity somewhat larger. The lungs lying in this cavity are filled by the air which rushes into the enlarged space. This enlargement of the chest cavity and the consequent filling of the lungs with air is known as an *inspiration*. After an inspiration, we allow the muscles to relax, and the ribs sink back, the diaphragm expands, curving up into the chest cavity, which becomes smaller and pushes the air from the lungs. This is an *expiration*.

Experiment. — To determine some products of respiration.

The necessity for deep breathing. — The blood carries back to the lungs carbon dioxide which has been formed in the body as a result of work it has done, and this carbon dioxide, as we have seen by the limewater test, is expelled from the lungs during expiration. The lungs during ordinary breathing do not expel more than one seventh of their total content of air. More of the air in



Tidal air is that air taken in and expelled during ordinary breathing. *Complemental air* is what we can take in, in addition to tidal air in a full deep breath. *Reserve air* is what we can force out in addition to tidal air by forced expiration. *Residual air* is that which always remains in the lungs.

the lungs can be expelled when we exhale deeply, but there is always some air left in the lung sacs known as residual air. This air must be very impure, as it lacks

oxygen and contains carbon dioxide and other waste products. It is highly important therefore that we frequently force out as much of this impure air as possible, and we can do this only by deep breathing. One of the best deep-breathing exercises is to raise the arms well from the sides and breathe deeply, hold the breath for three seconds, drop the arms and exhale. Repeat fifteen times. This should be practiced several times daily in the open air.

Water vapor and carbon dioxide are wastes given off through the lungs. — A study of chemistry shows us that wood, which contains carbon and hydrogen, combines with oxygen it produces two substances, carbon dioxide and water vapor. A chemist writes these two substances as CO_2 (carbon dioxide) and H_2O (water). *Chemical elements* are substances which have never been reduced to simpler substances; oxygen, hydrogen and carbon are examples. These elements always unite in definite proportions to form new substances, called *chemical compounds*. For example, water is always composed of $\frac{2}{3}$ hydrogen and $\frac{1}{3}$ oxygen by volume, no matter how much water there may be. Foods contain carbon, oxygen, and hydrogen, which, when they are oxidized in the body, produce compounds; among these are carbon dioxide and water.

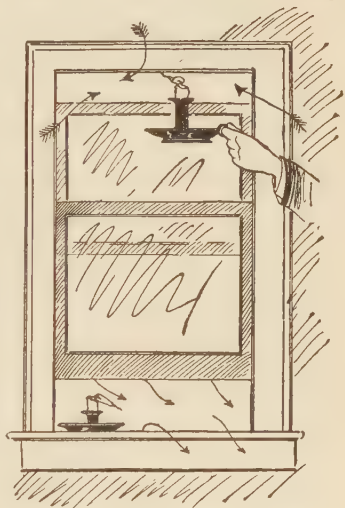
Need of ventilation. — It becomes necessary when people are gathered, in schoolrooms, churches, "movie" theaters, and in the rooms of their own homes, to have the air constantly changed in order to get rid of the odor, moisture and carbon dioxide, and to supply fresh dry air with oxygen. In breathing we do not take all of the oxygen from the air nor is the carbon dioxide given out from the lungs

poisonous. Recent experiments have shown that a man can live in an atmosphere containing only 10 per cent oxygen with apparently no bad effects. You are all familiar with the feeling of discomfort one has in a close and "stuffy" room. This discomfort is due principally to the increase in humidity, or water content of the atmosphere, in the room. Circulation of the air, which may be brought about by electric fans, blowers, etc., in large rooms, or by proper ventilation by means of windows in small rooms, will prevent this discomfort to a certain extent. On the other hand, some water in the atmosphere is absolutely necessary for health. In most artificially heated rooms the air is far too dry for health, and people who live in them take cold easily when they go out of doors. Air may be kept moist by the evaporation of water kept in pans on the radiators and registers. Some circulation is also due to the difference in the weight of hot and cold air.

Let us try an experiment to show how to ventilate properly as a basis for home study.

Experiment. — To demonstrate the principles involved in ventilation.

Dust and its dangers. — Not very many years ago an eminent New York physician wrote a book entitled "Dust



This shows the direction of air currents when it is warmer indoors than out. Can you account for this?

and Its Dangers." The dangers, as he pointed out, are not in the dust itself, but in the presence of many tiny living organisms known as bacteria, yeasts, or molds, in the dust. It is very easy to prove the presence of these organisms in the air of the schoolroom. A previously prepared culture medium¹ should be poured into a Petri dish (a small



Plate culture exposed for five minutes in a school hall where pupils were passing to recitations. Each spot is a colony of bacteria or mold.

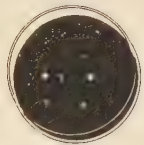
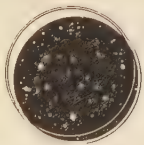
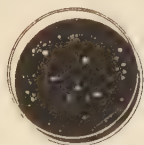
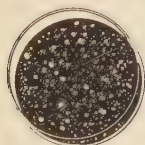
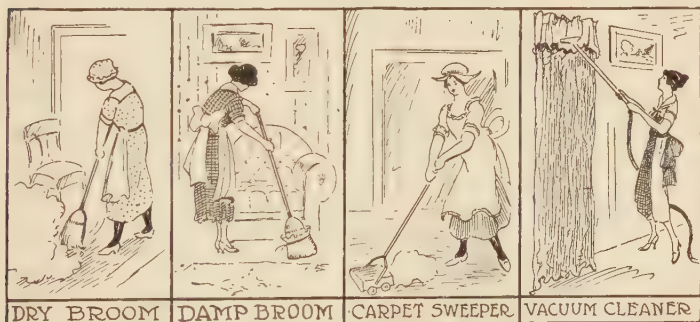
glass dish with a loosely fitting glass cover) and the dish and contents thoroughly *sterilized*, or rendered free from all living matter by means of heating. If this dish is opened for five minutes, exposing the surface of the culture medium to the air of the room, then closed and put away in

a warm dark place for two or three days, a number of little dots of different sizes and colors will be found growing on the surface of the culture medium (see illustration). These little masses of material increase in size day by day. They must be alive and must have grown from others which were alive before them although in-

¹ This culture medium may be bought already prepared. It is a gelatine or agar-agar preparation upon which germs grow readily and has been previously rendered free from all living things by sterilization.

visible. Since everything in the dish was dead, we have to conclude that they came from the air. If we were to examine the growing material under a very high-power microscope, we should find it composed of millions upon millions of tiny forms known as bacteria or molds. These tiny organisms thrive in our homes under conditions which we shall investigate more thoroughly later.

Proper methods of sweeping and dusting. — If these organisms are present in dust, it is important for us to

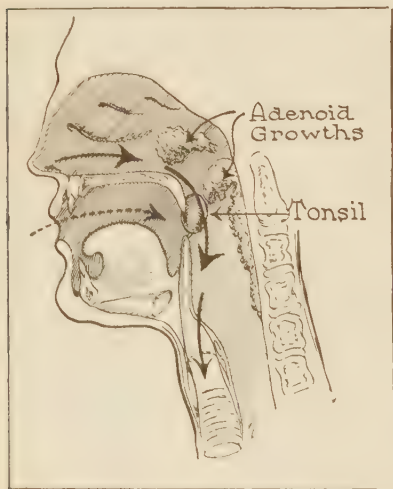


Which of the above methods is the best? What evidence is shown?

have methods of sweeping and dusting which will dispose of them without scattering them in the air we breathe. A good home project for girls and boys would be the working out of the best methods for cleaning their homes. For those fortunate enough to have electricity, an electric vacuum cleaner which sucks up the dust and dirt without filling the air with it is the best method. Floors should

be wiped with a damp or oily cloth rather than swept. Why? An interesting problem would be: To determine what method of cleaning in the home is the most hygienic. Suggest four methods of cleaning and consequently four different conditions under which you could expose prepared Petri dishes in your home.

Diseases of the air passages. — Nearly everybody has a cold at one time or another, even if they are fortunate enough to escape the ravages of influenza and pneumonia. Other diseases which attack the air passages are diph-



Section of head and neck showing position of adenoids and tonsils.

theria, tonsillitis, laryngitis, pharyngitis, bronchitis, catarrh, croup, and whooping cough. We should avoid close contact with anyone who has one of these diseases because they are caused by germs which are more or less contagious.

Adenoids and tonsils. — Tonsils in which germs lodge and grow cause many diseases and often make much

trouble. Infected tonsils should be removed. Enlarged adenoids grow in the back part of the nose, and shut off the air supply. This is accompanied usually by breathing through the mouth, snoring at night and by a general listlessness and indifference to work and play. They should be treated, or removed if very large. The operation

is a slight one and the results may make a very great difference to the general health.

Artificial respiration. — Accidents which interfere with respiration are drowning, suffocation from gas, stoppage of the nose or throat, and electric shock. In case of any accident in which breathing stops, it is necessary to work quickly. Send for a doctor at once. The person should

be taken into the open air, the clothes loosened, and artificial respiration started as soon as possible. In the case of apparent drowning, the first thing to do is to get the water out of the lungs and air passages. To do this we must raise the lower part of the body of the patient from the ground so



FIGURE 1.

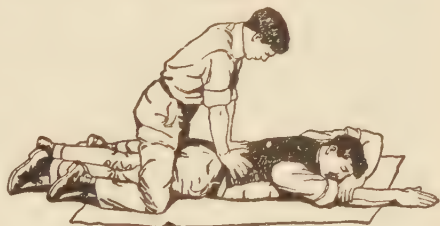


FIGURE 2.

Shaefer method of artificial respiration.

that the water may run out. With the arms underneath the abdomen lift the patient up quickly two or three times with a jerk. Water from the lungs will thus be forced out. Do not take more than half a minute to do this. Place the patient on the ground face down, and with head turned to one side and resting on an arm so that air can get in through the nose and mouth. Kneel astride of the patient, without resting any weight on him. Place the palms of your hands across the small of his

back, thumbs touching, and allow your weight to fall on your wrists by bending your body forward. This decreases the size of the patient's chest cavity and forces air out of his lungs. Now release the pressure by swinging backward quickly. The elastic chest of the patient will regain its original position, thus enlarging its cavity and drawing air into the lungs. Continue these motions about fourteen or fifteen times a minute, for several hours, if necessary. Victims of drowning accidents have been brought back to life after hours of work. If there are others to help, have them rub the arms and legs toward the body, as this helps the circulation, and cover the patient with warm blankets and place hot water bags at the hands and feet. After consciousness has returned warm drinks may be given.

In case of suffocation, where the patient has lost consciousness, start artificial respiration as directed above, and send for a doctor at once. In case of electric shock a rescue must be effected first. Remember that live wires transfer electricity through the body of the victim and do not touch him with your hands. To prevent a shock it is necessary to stand on dry wood, cloth, or rubber, and remove the wire with a piece of dry wood, or cut it with an ax having a dry wooden handle. If the patient lies on the wire, place coats under his head and feet and lift him off. As soon as you have rescued the victim start artificial respiration at once, for time is a very important factor, especially if he has become unconscious. Treatment for lightning shock is the same as for electric shock.

Fainting. — A fainting attack is brought on by a decrease in the amount of blood in the brain. A person feeling dizzy should lie down with the head lower than

the body as this will often prevent fainting. Abundant fresh air and loose clothing are helps. Enforced respiration shortens an attack. Respiration may be stimulated by throwing cold water upon the face and chest. Aromatic spirits of ammonia may be inhaled also, but avoid letting any drop into the eye or irritating the air passages unduly by holding it too near the mouth or nose.



Why is the head lower than the rest of the body?

REFERENCE BOOKS

- Allen, *Civics and Health*, Chapters V, VI (For teacher). Ginn and Company.
- *American Red Cross Textbook on First Aid*. Blakiston's Son and Company
- Broadhurst, *Home and Community Hygiene*, Chapters IX, XI (Teacher's use). J. B. Lippincott Company.
- Chapin, *Sources and Modes of Infection* (Teacher's use). J. B. Lippincott Company.
- Fisher and Fisk, *How to Live*, Chapter I (Advanced readers). Funk and Wagnalls Company.
- Hill, *The New Public Health*, Chapters III, IX, XV (Teacher's use). The Macmillan Company.
- Hough and Sedgwick, *The Human Mechanism*. Ginn and Company.
- Hunter, *A Civic Biology*, Chapters XXI, XXII. American Book Company.
- Hunter, *Laboratory Problems in Civic Biology*. American Book Company.
- Lee, *Health and Disease*, Chapters VIII, XII (Teacher's use). Little, Brown, and Company.
- *New York State Ventilation Commission Report* (Advanced readers).
- Prudden, *Dust and Its Dangers*. G. P. Putnam's Sons.
- Ritchie, *Primer of Sanitation*, Chapters XX, XXI. World Book Company.
- Woods Hutchinson, *Preventable Diseases*. Houghton Mifflin Company.

CHAPTER IV

WATER IN THE HOME

Problems. — 1. *To understand the cycle of water in nature.*

2. *What are the available sources of a home water supply?*
3. *How can you tell safe from unsafe water?*
4. *How can water be brought into the home?*
5. *What is a "solution"?*

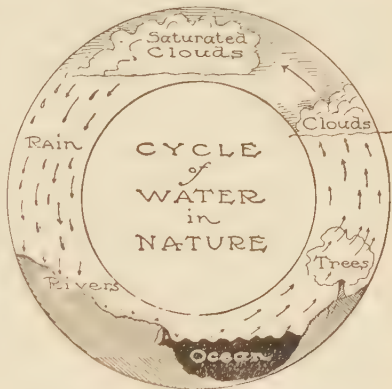
Suggested projects. — 9. To make a lift pump.
10. How much water is wasted by dripping faucets?

Pure water. — Pure water is a chemical compound formed by the union of two parts of hydrogen and one of oxygen and nothing else. When other substances are mixed with water as is usually the case, pure water may be obtained by separating it from the impurities. There are several methods for doing this, the best one is by the process of distillation.

Rain water. — Rain water is very pure, for it is made from pure water vapor which is condensed in the clouds high in the air. Breathe on a cool glass. What happens? The little drops of moisture have become condensed because warm, moist air was suddenly cooled. Moisture in the air comes from the evaporation of water from all wet surfaces. Leaves give off a large amount of moisture in the form of water vapor. An acre of clover may give off from 500 to 750 tons of water during a single season

and an acre of Indian corn gives off nearly a thousand tons of water in a season. When this moisture in the air condenses clouds result. From clouds water falls to the earth as rain.

How we collect rain water. — In many parts of the world people drink rain water. On the islands of Bermuda for example, the people depend entirely upon rain water and in order to collect a supply of it, they cut great cisterns in solid rock. If rain water is collected in clean cisterns or barrels it is perfectly pure but unfortunately it is often collected and stored in receptacles which are not clean. It is an excellent plan to have



Explain this diagram.

the first water which falls run off without entering the barrel or cistern, because that water is almost sure to contain dust and other impurities from the air. The best type of cistern is a tank of non-porous material placed in the ground.

Springs and wells. — Have you ever realized that spring water was originally rain water? The rain soaks into the ground until it comes to a layer through which it cannot pass (*impervious layer*). It then seeps along through a porous layer acquiring pressure as its volume increases. If the saturated zone comes to the surface a spring may result. A glance at the accompanying diagram will show how

springs occur. In a gushing spring the water is forced out under pressure. Water which has soaked into the ground often travels between two layers of impervious material,

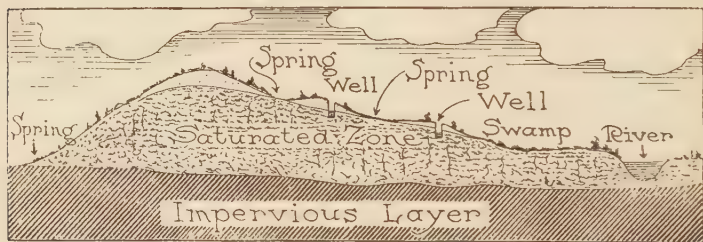
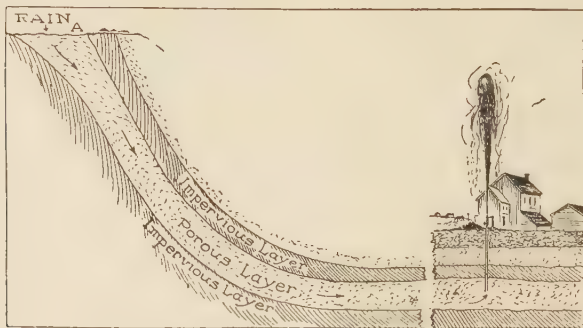


Diagram to show the relation of springs and wells to underground water.

following along some layer of soil or rock which allows its passage, and finally finds its way to the surface through a crack or hole in hard rock at some point far distant



Conditions making an artesian well possible.

from where it entered the soil. Artesian wells are made when deep holes are drilled into the ground and such underground water sources are tapped. Sometimes water may come from a much higher altitude and run underground for a distance, so that pressure causes the water

to shoot into the air to some height when the vein holding it is tapped.

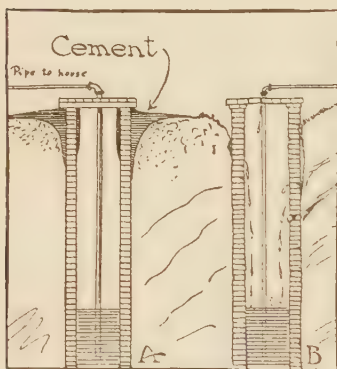
What is impure water? - Health officials consider water pure unless it contains something that is injurious to health. Water containing ordinary dirt or mud will not cause illness although it may have an unpleasant appearance. Disagreeable tastes and odors come from decay and from organisms living in the water — but these are not necessarily injurious to health. As germs of different kinds exist in the food tube of a person's body, and are passed off with the excreta or wastes, it is evident that water which contains sewage is impure. Such water is called *polluted* and is unfit for use. Any water drawn from the surface of the land is likely to contain wastes and disease germs, and hence is more dangerous than water coming from underground.



A spring located like this one is deadly. Are there any such in your locality?

Safe wells and deadly ones. — Many of us who have visited the country on our vacations remember with pleasure the cold water from a deep well or hillside spring possibly near a farm house. Although such water tastes good it is sometimes impure. Look at the picture and see how a spring may be polluted by a cesspool.

The water in wells is polluted frequently unless protected from the surface drainage. Study the picture of the two wells shown here, and explain why the building of a concrete parapet which slopes away from the opening will protect the water in the well. Drainage from



Would you choose your water supply from A or from B? Why?

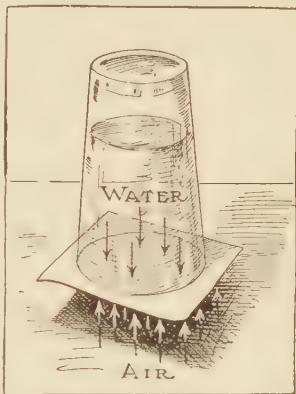
the soil may mean that impurities reach the well. In addition to surface protection the well should be so placed that the land drains away from it and that impure water does not flow in through an underground channel. If one is uncertain as to the purity of the water, a sample may be sent to the town or state bacteriologist, to determine if it is safe to drink. A

driven well in ordinary sandy soil situated on a slight elevation at least 100 feet from a cesspool or barnyard with a pipe which is driven in deep, will give pure water. This is a particularly safe kind of well.

How we get water into our houses. — This is a problem that the city dweller does not think much about, because he receives water supplied directly to his home through pipes. The problem of city water supply will be taken up later. It is quite easy sometimes for the country house to have running water in it if the spring or other source is above the house level. If the source of supply is below the house the problem is more difficult.

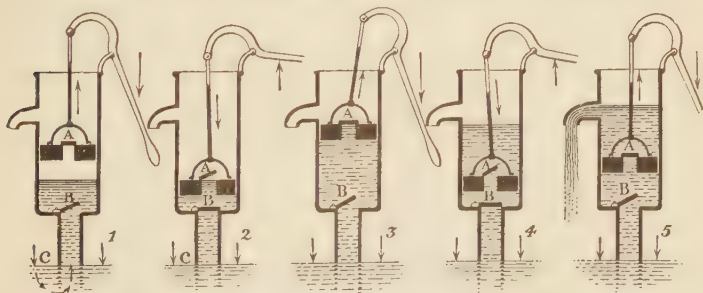
A knowledge of air pressure is necessary in order to be

able to plan how to deliver water into the house. We have already seen that air has weight. If you place a smooth card over a tumbler of water and invert them carefully, you can lift the tumbler with the water in it and the card will not fall off. A moment's thought will tell you that something is pressing upward on the card, or that the air pressing against the card weighs more than the water held in the glass. We must apply this same principle of air pressure to the pump in order to understand how it works.



The water is held in the glass by the upward pressure of the air.

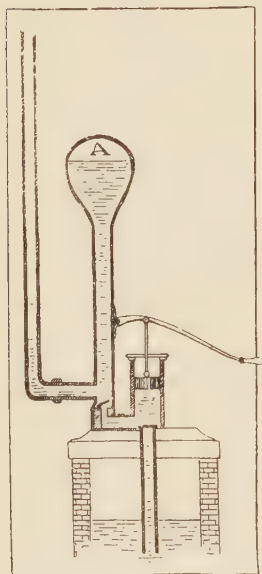
The tube of the pump extends down into the water of the well or cistern. The upper part holds a piston (see diagram) containing a lifting valve (A). Another valve (B) is placed at the top of the tube just



The lift pump.

where it enters the barrel of the pump. When the piston is raised the water is pushed into the tube by the weight of the air pressing down on the water in the well or cistern

When the piston is lowered the valve in the piston opens, thus allowing the water to run into the space above the piston. On the next upward stroke of the piston this



The force pump.

water which is held above is lifted higher in the tube until it flows out of the pump. This pump, known as the *lift pump*, will raise water to a height of about 33 feet only because the weight of the air, which presses down with a force of fifteen pounds to the square inch upon the surface of the water in the cistern, cannot balance a column of water higher than 33 feet. In practice the lift pump will rarely raise water more than 28 feet because of leakage around the piston and valves.

Water may be lifted above twenty-eight feet by the use of a *force pump* as illustrated in the accompanying diagram. Study it carefully and explain why we are able to raise water higher by this method than by the lift pump. Chamber A holds air which may be compressed in order to give a continuous flow of water. Can you explain how it does this?

Demonstration. — To Show the Use of the Pneumatic Tank.

Materials: An eight-ounce bottle, with wide mouth. Two-hole rubber stopper. Glass tubes. Force pump. Ring stand. Rubber tubing. Beaker.

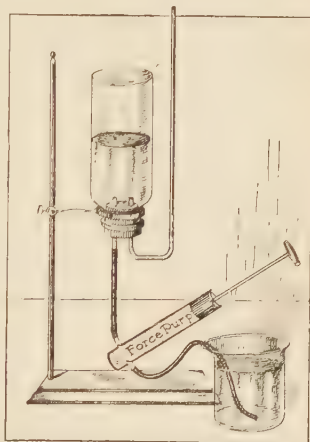
Method: Invert the bottle and support it on the ring stand. Make a U bend at one end of a four-foot glass tube. Insert the short arm of this tube into the rubber stopper. One end of the other glass tube

is connected by a rubber tube to the outlet valve of the force pump and the other end is put into the rubber stopper. The inlet valve of the pump is connected by a rubber tube to a beaker of water. Wire the stopper securely in the mouth of the bottle. Pump water into the bottle, which is already full of air. As the water presses the air into a smaller space, note how the water rises in the glass tube. Connect another four-foot length of glass tubing on top of the first one and continue pumping until the bottle is nearly $\frac{1}{4}$ full of water.

Observations: As water enters the bottle what change occurs in the air space? How high does water rise in the discharge tube?

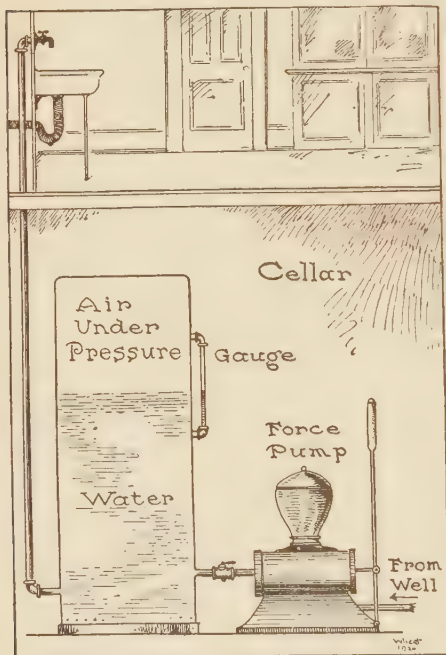
Conclusions: What changes does the air in the bottle undergo? What useful work can be done by taking advantage of one of these changes?

Application: Apply this principle to a house supply. How high could the water be raised if the air in the bottle were compressed to half its original volume?



The pneumatic tank system. — In some houses a supply system by which water can be piped and sent to all parts of the house is obtained through the use of a *pneumatic tank*. (See illustration on page 70.) Water is forced into the tank and the confined air above it is compressed so that it exerts great lifting power. Thus when the tank is $\frac{3}{4}$ full of water the air is compressed to $\frac{1}{4}$ of its original volume and the pressure becomes four times that of the atmosphere, or four atmospheres. Such a pressure will force water easily higher than the top of an ordinary house. Whenever a gas is reduced in volume $\frac{1}{2}$, its pressure is doubled. Hence when a tank is $\frac{3}{4}$ full of water the air which is compressed to $\frac{1}{4}$ its volume will have

enough pressure to lift water over 130 feet if no outside air were pressing against it, or about 100 feet against the pressure of the air.

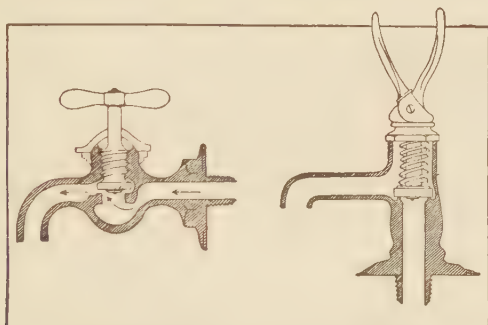


Pneumatic tank system of distribution of water.

Faucets. — To provide for an adequate water supply, pipes are arranged in the house to carry the water from the place where it enters to the various rooms where it is used. A cut-off valve is placed close to the point where the water enters the house. Why? In order to obtain water when we wish it and to check the flow at other times a device called the *faucet* is necessary.

A careful study of the two diagrams will show how two types of faucets are operated. The kind most frequently used is the screw faucet. In this type, as the handle is screwed down, a washer, which may be a round perforated disc, is forced down over the opening, thus shutting off the flow of water. In another common type of faucet, the pressure of a spring holds the washer down so that no water can get out. When the handles are squeezed together, this pressure is released and the water flows through.

How to stop faucets from dripping. — Any handy boy, or girl, for that matter, should know how to stop faucets from dripping. The first thing to do is to turn off the



Two types of faucets: screw and spring.

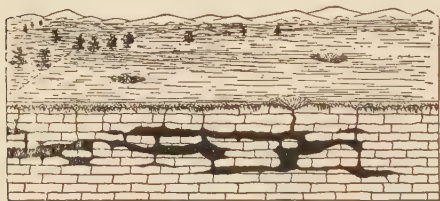
supply of water at the cut-off in the cellar, then take off the handle of the faucet with a wrench and remove the washer. The washer will probably be either broken or badly worn and a new one, which can be procured at any hardware store, should be inserted and the handle replaced.



Water waste per year.

Sometimes a faucet gives an annoying noise, due to vibration when the water passes through. If caused by a loose washer it is easily remedied. Leaky faucets waste money; do not allow any of them in your home.

What solution means. — You know that sugar placed in lemonade soon dissolves in it and disappears, but the sugar may be tasted in all parts of the glass of lemonade. The sugar passes from the solid to the liquid state by



Formation of caves by water running through limestone.

a physical process known as *solution* and it is distributed to all parts of the liquid by *diffusion*.

When a substance completely dissolves in a liquid so as to

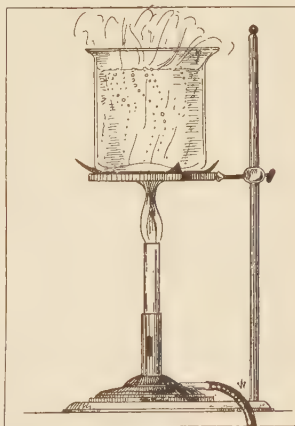
become a permanent part of it, we say the substance is *soluble* and that we have a solution. Rain water, although perfectly pure as it drops from the clouds, after soaking into the ground may soon take up into itself mineral matter by solution. Certain minerals, particularly compounds of calcium (lime) and magnesium, are slightly soluble in ground water, and in some parts of the country, great gaps and caves have been formed by water running through limestone and dissolving it out gradually.

Hard and soft water. — Water that has taken up a considerable amount of calcium salts is called hard water, while that which has little or no dissolved mineral matter in it, as rain water, is called soft. Soap does not readily make a good lather, or suds, with hard water — as it does with soft — but comes to the top in a sticky, insoluble scum. Soap breaks grease up into tiny droplets forming an emulsion in which condition it is carried off in the water. Hard water leaves a deposit in kettles, and feels harsh to the hands. It is good to drink, but must be treated with chemicals or softened before using for washing

purposes to prevent using a wasteful amount of soap. Washing soda added to the water before the soap will usually make the water better suited for washing, because the soda combines with the lime in the water, changing it to an insoluble form, so that it does not affect the soap.

How we may make water pure. — We have already seen that harmful water contains germs which do harm when they are alive. Any method which kills them without injury to the water therefore renders it safe to drink. Boiling water for a period of at least ten minutes will kill practically all germs, so that we may safely drink such water. Unfortunately, boiled water has a flat and unpleasant taste, due to the fact that the air which was held in solution has been forced out of it. In order to make such water palatable we may shake it up in a bottle half full of air or allow it to stand exposed to the air. In this way water dissolves some air and again assumes a palatable taste.

Particles of suspended solids may be removed from water by filtering through sand, and organic coloring is removed by filtering through powdered charcoal. Small filters may improve the appearance of water but cannot be depended upon to remove germs. The ordinary faucet filter, unless cleaned every day, is soon so charged with



Notice the bubbles of air which escape when water is first heated. Why is boiling water sometimes recommended?

WATER IN THE HOME

SCORE CARD. WATER IN MY HOME

	EXCELLENT	FAIR	VERY POOR	MY SCORE	
					Total
A SAFE WATER SUPPLY	Water protected from surface drainage (deep) (5) Water without sediment (1) Water having no color (1) Water having no odor (2) Use of bottled water for drinking (1)	Water from shallow source protected against surface drainage (3) Water having some sediment (½) Water having slight color (½) Water having slight odor (1) Boiled water for drinking (1)	No protection from drainage. Cess-pool or privy within 100 ft. (0) Much sediment (0) Much color (0) Much odor (0) Neither boiled nor bottled water for drinking (0)	.... .... .... .... ....	....
AMPLE WATER SUPPLY	Always enough water for all purposes at all seasons including possible fire (5) Head of water sufficient to throw stream over house (5)	Supply only to two lower floors of home (3) Supply sometimes low in summer or winter (3)	Supply only to lowest floor of house (2) Supply usually low in winter or summer (1)	.... ....	....
ALL PARTS SUPPLIED WITH PIPING AND FIXTURES	Water supplied under pressure to bathroom (1), toilet (2), sink (1) and washtubs (1) No pumps: gravity system: piped to all parts of the house (5)	Water supplied under pressure from pneumatic tank to bathroom (1), toilet (2), sink (1), tubs (1)	Pumps: no pneumatic tank. Water supplied only to sink (1), tubs (1)	.... ....	....
CONDITION OF PLUMBING	Pipes in good condition; no leaks (2) Faucets all tight; no dripping (2) Pipes never freeze (2) Plumbing all exposed (2) No odors (2)	Pipes in fair condition; sometimes leak (1) Faucets drip at times (1) Pipes freeze in very cold weather (1) Plumbing partly exposed (1) Slight odor at times (1)	Pipes old and leaky (0) Faucets constantly drip (0) Pipes freeze in ordinary winter weather (0) No exposed plumbing (0) Much odor from plumbing (0)	.... .... .... .... ....	....
SOFT WATER PROVIDED	Water is soft (4) Rain water and cement cistern (3) Bucket pump or other means of mixing air with water (2) Flow-off of first rain water from roof (1)	Water of medium hardness (2) Rain water in tightly covered barrel (1) Water falls from height into barrel thus mixing air with it (1) Roof clean, water-proof paint (1)	Water very hard (0) Rain barrel exposed, no tight cover (0) No method of mixing air in water (0) Water smells or is dirty (0)	.... .... .... ....	....
GRAND TOTAL				PERFECT SCORE 50	
					

impurities that it is worse than no filter at all, for germs can easily pass through most faucet filters.

Scoring my home water supply. — Any boy or girl who has read this chapter with thought realizes the importance of a pure water supply. Those who live in cities with a good water supply provided for them have a great advantage over those who have no safe supply or one which is not delivered in pipes. The score on the preceding page will probably be much higher for those who live in the city than in the country.

REFERENCE BOOKS

- Barber, *General Science*, Chapter IX. Henry Holt and Company.
Broadhurst, *Home and Community Hygiene*, Chapter V. J. B. Lippincott Company.
Butler, *Household Physics*. Whitcomb and Barrows.
Caldwell and Eikenberry, *General Science*, Chapter IX. Ginn and Company.
Clark, *Introduction to Science*, Chapter XXXIV. American Book Company.
Hazen, *Clean Water and How to Get It* (Teacher's use). John Wiley and Sons.
Hoadley, *Essentials of Physics*. American Book Company.
Hunter, *A Civic Biology*, Chapter VI. American Book Company.
Lynde, *Physics of the Household*. The Macmillan Company.
Ritchie, *Primer of Sanitation*, Chapter XX. World Book Company.
Smith and Jewett, *Introduction to the Study of Science*, Chapter V. The Macmillan Company.
Yearbook, U. S. Dept. Agri., *Clean Water and How to Get It on the Farm*.
Weed, *Chemistry in the Home*, Chapter III. American Book Company.

CHAPTER V

FOODS IN THE HOME

Problems. — 1. *To learn the uses of foods.*

2. *To learn of what our bodies are made and what must be supplied if we are to grow.*

3. *To learn how to tell what different nutrients foods contain.*

4. *To learn how and where food is made ready for absorption.*

5. *To determine reasons for differences in diets.*

6. *How to select a proper and economical variety of food.*

7. *How and why foods should be cooked.*

Suggested projects. — 11. Nutritive value and cost of foods commonly used in my home.

12. To obtain starch from potatoes.

13. Testing and preserving eggs for home use.

14. To pasteurize the home milk supply.

15. To make an iceless refrigerator.

What are foods? — This does not seem a very difficult question to a hungry girl or boy but the scientist considers it from a different point of view. He knows that ever since you were born you have taken into your body certain substances and as a result you have grown in size and weight. In addition to this, you have displayed more or less activity of body and mind. The scientist has applied the name *food* to those things that build up the body or supply it with energy.

Demonstration Experiment. — A Demonstration to Show the Presence of Carbon in Wood and in Sugar

Materials: An earthen plate. A 500 cc. beaker. Sugar. Concentrated sulphuric acid. Measuring cylinder. A wood taper.

Method: (a) Dip the wood taper into the acid and withdraw it quickly.

(b) Dissolve 60 grams of sugar in 45 cc. of water in the beaker. Place this on the plate. Pour 60 cc. of concentrated sulphuric acid into the sugar solution.

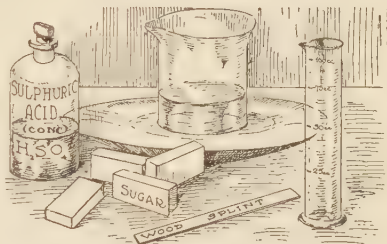
Observations: Write an account of changes which you have observed.

Explanation: Sulphuric acid has a strong chemical attraction for water and when mixed with it produces a high temperature. It will withdraw water from substances like wood and sugar.

When water is taken away from wood the element carbon only is left, just as when water is driven off by heat. Carbon is black and consequently both the wood and sugar turn black after being treated with the acid. The sugar carbon is made porous and increases in bulk because of the escaping bubbles of steam.

Applications: What will happen to a sugar solution boiled on the stove? Is there any reason why it is better to add sugar to some foods after they are cooked than before or during the cooking?

Note: (If performed as an individual pupil experiment use one fourth quantities suggested.)



Why we need foods. — If we were able to change all kinds of foods back into the chemical elements of which they are composed, we would find them consisting chiefly of carbon, hydrogen, oxygen and nitrogen. In addition to these four elements many foods contain a very small percentage of mineral salts. A chemical analysis of the human body shows that it is made up of about 72% oxygen, 13.5% carbon, 9% hydrogen, 2.5% nitrogen, about 3% of various mineral salts, including calcium, phosphorus.

potassium, sulphur, sodium, chlorine, magnesium, iron, and some others. All of these substances are found in various kinds of foods. Carbon, oxygen, hydrogen, and nitrogen, for example, are obtained from such foods as meats and vegetables. Some of these chemical elements have extremely important uses; for example, the presence

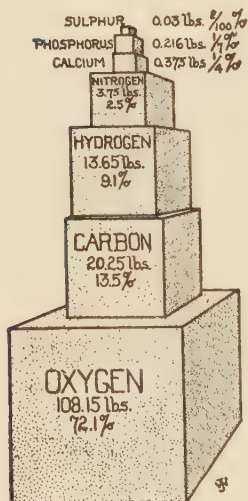


Chart to show the percentage of chemical element in the human body.

of very minute quantities of certain mineral salts in the body control the beating of the heart, the contraction of muscles, and the ability of nerves to send messages. More than this, it has recently been discovered that there are certain mysterious, regulative substances, called vitamins, which are found in milk, eggs and certain vegetables and fruits without which the body cannot be properly nourished. The body uses food also much as an engine uses fuel, and obtains from the food the energy which is displayed on the playground, in the home and the school-room.

Experiment. — Tests for the carbohydrates, sugar and starch.

The nutrients and where they are found. — Scientists have shown us that our common foods are made up of substances called *nutrients*, which are known as proteins, fats, carbohydrates, mineral matter, and water. Three of these nutrients, *protein*, *fat*, and *carbohydrate*, are consumed in the body to release energy or are used for building new tissues. The mineral matter assists in the making

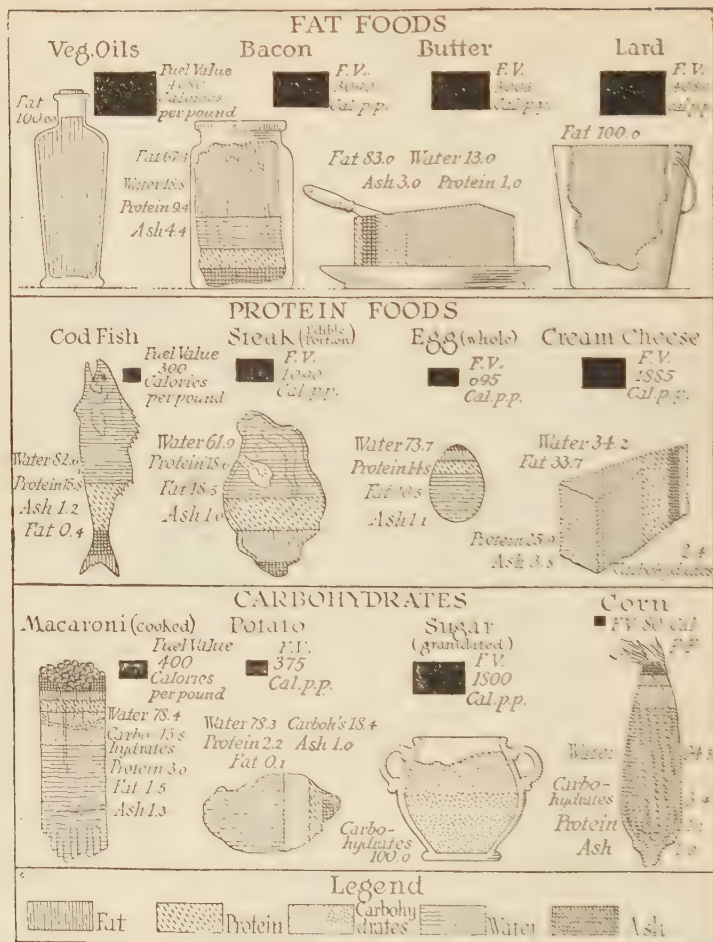
of bone, in carrying on digestion, and in other body functions, while the water is used largely as a vehicle to carry the nutrients in solution, and forms a very large percentage of the bulk of the human body. Carbohydrates form the chief nutrient in cereals, breads, cake, fleshy fruits, sugars, jellies, and the like. Fats and oils are found in nuts and some grains, and make up the greater part of bacon, pork, lard, and butter. Animal foods yield our chief supply of protein. White of egg and lean meat are almost pure pro-



These rats are the same age. They were always fed the same kinds and amounts of food, namely, bread 60%, potatoes 20%, greens 20%, but the one at the left had in addition a tablespoonful of milk daily. Certain vitamins are found in milk. (Photo from Battle Creek Sanitarium.)

tein and water. Proteins are most abundant in those plants which are richly supplied with nitrogen such as peas and beans, grains and nuts.

Vitamins and their uses. — Recent studies have shown that some foods possess peculiar substances known as *vitamins* which are essential to health. For example, one of the German raiders was forced to put in at Newport News and have its crew interned because of severe illness among its members. The men had apparently all the food necessary, for they had sunk ship after ship and had taken canned goods, wheat flour, and other materials in abundance. The officers had fresh vegetables from time to



time while the crew had none, and after a period of nearly three hundred days, a large number of the crew became so ill that medical attention was necessary. When these men were given a diet of fresh fruit, milk, eggs, and soups

FOODS CONTAINING VITAMINS¹

	"A"	"B"	"C"		"A"	"B"	"C"
BREAD, WHITE (WATER).....	?	+	—	TOMATOES (RAW OR CANNED).....	++	+++	+++
" " (MILK).....	+	+	?	BEANS, KIDNEY.....	*	+++	*
" WHOLE WHEAT (WATER).....	+	++	?	" , NAVY.....	*	+++	—
" " " (MILK).....	++	++	?	" , STRING (FRESH).....	++	++	++
BARLEY (WHOLE).....	+	++	—	CABBAGE, FRESH, RAW.....	+	+++	+
CORN, YELLOW.....	+	++	—	" , COOKED.....	+	++	+
OATS.....	+	++	—	CARROTS, FRESH, RAW.....	++	++	++
MEAT, LEAN.....	— to +	+	+	" , COOKED.....	++	+	+
BEEF FAT.....	+	—	—	CAULIFLOWER.....	+	++	+
MUTTON FAT.....	+	—	—	CELERY.....	*	+	*
PIG KIDNEY FAT.....	++	—	—	CUCUMBER.....	*	+	*
OLEOMARGARINE.....	+	—	—	DANDELION GREENS.....	++	++	+
LIVER.....	++	++	+	EGGPLANT, DRIED.....	+	++	+
KIDNEY.....	++	++	+	LETTUCE.....	*	++	+++
BRAINS.....	+	++	+	ONIONS.....	*	++	++
SWEETBREADS.....	+	+	*	PARSNIP.....	—?	++	*
FISH, LEAN.....	—	+	*	PEAS.....	++	++	+
" , FAT.....	+	+	*	POTATOES (BOILED 15 MIN.).....	*	++	+
" , ROE.....	+	++	+	" (" 1 HOUR).....	*	++	+
MILK, FRESH.....	+++	++	+V	" (BAKED).....	*	++	+
" , CONDENSED.....	+++	++	+V	SWEET POTATOES.....	++	+	*
" , DRIED, (WHOLE).....	+++	++	+V	RADISH.....	*	+	*
" , SKIMMED.....	+	++	+V	RUTABAGA.....	—?	++	+++?
BUTTERMILK.....	+	++	+V	SPINACH, FRESH.....	+++	+++	*
CREAM.....	+++	++	+V	" , DRIED.....	+++	++	*
BUTTER.....	+++	—	—	SQUASH, HUBBARD.....	++	+	*
CHEESE.....	++	*	*	TURNIPS.....	—?	++	*
COTTAGE CHEESE.....	+	*	*	APPLES.....	+	+	+
EGGS.....	++	+	+	BANANAS.....	+	+	+
ALMONDS.....	+	+	*	GRAPE JUICE.....	+	+	+
COCONUT.....	+	++	*	GRAPEFRUIT.....	*	++	++
HICKORY NUTS.....	*	++	*	LEMON JUICE.....	*	++	+++
PEANUTS.....	*	++	*	ORANGE JUICE.....	+	++	+++
PECANS.....	*	+	*	PRUNES.....	*	+	—
WALNUTS.....	*	++	*	RASPBERRIES (FRESH OR CANNED).....	*	*	+++

+...contains the Vitamin
 ++...good source of the Vitamin
 +++...excellent source of the Vitamin
 —...no appreciable amount of the Vitamin

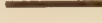
?...doubt as to presence or relative amount
 *...evidence lacking or insufficient
 V...variable

American Medical Ass'n.

¹ Vitamins are classified as "A," "B," and "C."

made of the boiled skins of vegetables, they were cured in a very short time. This indicated that they needed the vitamins which were present in these foods. The chief sources of vitamins for us are the outer coats of rice (un-

FOODS IN THE HOME

FOOD MATERIALS	PROTEIN		FATS		CARBOHYDRATES		FUEL VALUE	
								
	PRICE PER CENTS	25 CENTS WILL BUY POUNDS	POUNDS OF NUTRIENTS AND CALORIES OF FUEL VALUE IN 25 CENTS WORTH					
			1 LB.		2 LBS.		3 LBS.	
			2,000 CAL.		4,000 CAL.		6,000 CAL.	
Beef, round	35	.71						
Beef, sirloin	50	.50						
Beef, shoulder	30	.83						
Mutton, leg	40	.63						
Pork, loin	30	.83						
Pork, salt, fat	30	.83						
Ham, smoked	45	.56						
Codfish, fresh, dressed	25	1.00						
Oysters, 90 cents per quart	45	.56						
Milk, 15 cents per quart	7½	3.33						
Butter	62	.40						
Cheese	40	.63						
Eggs, 60 cents per dozen	40	.63						
Wheat bread	12½	2.00						
Corn Meal	7	3.00						
Oat Meal	10	2.50						
Beans, white, dried	12½	2.00						
Rice	8	3.00						
Potatoes, \$1.50 per bushel	2½	10.00						
Sugar	10	2.50						

On the basis of cost and food values shown in the above table, make an economical dietary for one day for a man engaged in light work. Make a second dietary to satisfy the same conditions but select expensive foods. Give reasons for the amounts and choice of foods in each case. What is the difference in the cost of these two dietaries? Do the prices given in the table agree with those in your community? If not work out the cost as *you* purchase foods.

polished or brown rice), potatoes, carrots, and some other vegetables; eggs, milk, and many fresh fruits, particularly oranges and pineapples.

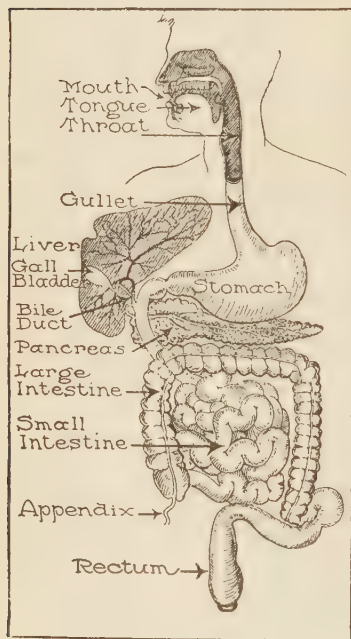
The daily food requirements of the body. — The amount of food necessary for the growth and the repair of the body and to supply energy has been determined by a series of experiments and may be given in definite terms. Chemists have a standard of heat measurements called the calorie which is used in this connection. A calorie is the amount of heat required to raise the temperature of one pound of water from zero to four degrees Fahrenheit (4°F). The value of foods in producing heat is determined and measured in calories. It has been found, that the average person needs each day from three to a little over five ounces of protein and enough heat-releasing food to furnish the body with from two thousand to three thousand calories. This means that an adult doing moderate work should eat about a quarter of a pound of protein, a quarter of a pound of fats, and a pound of carbohydrates each day. More food is needed when hard work is done. Children do not need as much food as adults unless they exercise violently, as in playing football, baseball, prisoners base or other active games. Boys and men exercise more than girls and women and require more food. Environment plays a very important part in diet. The inhabitants of cold countries need heat-releasing foods, and use fats for this purpose. People living in hot climates need watery foods, such as fruits, vegetables, milk, eggs and cereals and but little fat and meat. Our diet should vary with more fats and meat in the winter and more fruits and vegetables in the summer.

How the human body makes use of food. — Food cannot be used by the body in the form in which it is eaten. In

order for food to get into the blood and become part of the body it must pass through the walls of the food tube which it entered after leaving the mouth. A solid material cannot pass through a thick wall. Therefore, the food materials must be so changed that they can pass through

a wall. This process of changing foods into such a form that they are able to pass through the walls of the food tube and become part of the blood is called digestion.

Where and how digestion takes place.—The accompanying diagram shows the complicated organs which make up the digestive system. Most of the digestion, contrary to common belief, takes place in the long coiled tube called the small intestine, into which, as well as into the mouth and stomach, digestive juices are poured.



Digestive tract.

These juices are secreted in glands and contain certain chemical agents known as *enzymes* which act upon insoluble foods causing them to become soluble. An example of such a change is found when an unsweetened cracker is chewed in the mouth. It soon begins to taste sweet and if tested shows the presence of grape sugar. Since unsweetened cracker con-

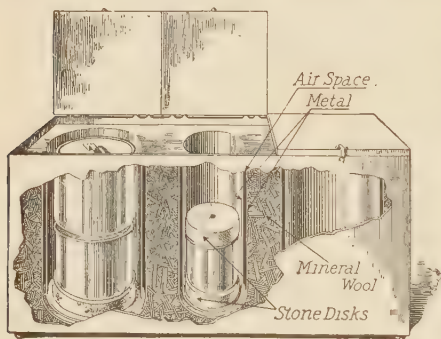
tains starch we conclude that something in the saliva caused this change or digestion to take place.

What cooking does to foods. — If we examine a bit of raw potato under the microscope, we find that the starch contained in it is in little pockets surrounded by thick walls. Cooking softens and breaks down these tough walls in vegetables and makes them less tough and more palatable in meat thus helping in their digestion. More than this, cooking destroys germs and other living organisms which might grow if taken into the body and thus makes foods safe which otherwise might be harmful.

Different methods of cooking. — In general there are four principal ways of cooking foods, boiling, broiling, frying, and baking. In boiling we place the food in water and heat to 212° F. An excellent method of cooking eggs is either to poach them in water just below boiling or to place them in a dish of boiling water, cover, take off the stove and leave for seven minutes. As the white of egg coagulates or hardens above 140° F. either of these ways will cook the eggs without making them indigestible. Milk should not be boiled, as this injures the protein. In making soups, where we wish to draw the nutriment into the water, the material should be put into cold water, brought to the boiling point, and then cooked slowly. If we wish to keep the nutriment in the material, it should be put into boiling water at once. In roasting and broiling use a high temperature at first in order to sear the outside of the meat and prevent the escape of juices. A hot fire should be used in cooking a steak so as to keep the nutriment within the browned surface. Frying is not a desirable method of cooking because fat is likely to soak into the foods, and render them less digestible.

In baking, the food should be placed in a hot oven first and the heat reduced later so that the inside of the substances can be cooked. Cooking starch at baking temperature changes it to dextrin, which is more easily digested than starch. The browning of the bread crust is due to this change.

Fireless cooker. — In these days nearly every household is provided with a labor-saving device known as the fireless cooker. An in-



Fireless cooker.

teresting home project would be to manufacture such a cooker. The principle of the fireless cooker is that of *insulation*. The food is put into a metal container with hot stone disks or iron radiators in a

box with heat insulating material filling the space between the container and the outer part of the box. The covers are tightly fastened, the food cooks slowly without losing its flavor. Food is cooked very thoroughly in this way, and at the same time fuel is saved.

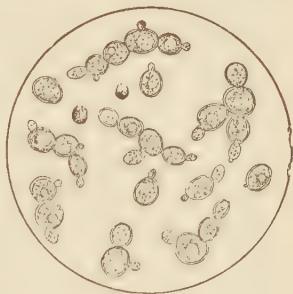
Why foods spoil. — Neither fresh nor cooked foods keep indefinitely. Peaches, pears, and apples rot; eggs, meat, and fish spoil; and milk and cooked cereals sour. Why does this happen? We know that foods will not spoil so soon if they are kept in an icebox or if cooked or canned; but why do foods become unfit for use eventually? Take small quantities of several different kinds of foods, for

example, milk, a piece of meat, potatoes, and cooked cereal, divide each into two equal portions, place in separate jars. Place these jars in a large pan of water and boil them for one hour. After boiling we think that everything which might have been living in the jars is dead. While still hot seal tight one jar of each kind of food, keeping the other open. An examination of their contents after four or five days shows that the food in the open jars has begun to spoil, while it is still good in the closed jars. Comparing this with our previous experiments with the air, we conclude that whatever causes the food to spoil comes from the air which is in contact with the food. The tiny plants of the home — yeasts, molds, and bacteria — are always present in the air, although we cannot see them, and when they lodge on food and grow, they cause certain changes to take place in the food which give it an unpleasant taste and odor.

In fact, its quality is so changed that it is no longer suitable to eat.

Yeasts and their work. — Everyone knows that yeast under certain conditions of warmth and moisture causes bread dough to “rise,” but it is not so well known that this condition is due to the growth and multiplication

of millions of tiny one-celled plants which were in the compressed yeast cake. Wild yeasts occur almost everywhere and cause the process of fermentation to take place under favorable conditions. In this process the yeast plants change the sugar on which they feed into carbon dioxide



Yeast plant.

and alcohol. This process will be easier to understand after you have studied chemistry. Yeast plants often get into sweet foods, especially fruits causing them to "work" and become unpleasant to taste.

Molds in the home. — Mold is one of the most common enemies of food in the home. If you place two pieces of



Three different types of mold plant. Notice the fruiting bodies, containing spores. 1. Cheese mold. 2. Corn smut. 3. Bread mold.

bread, one moist, and the other dry, side by side in the kitchen or living room, the dry bread will remain unchanged and a fuzzy growth will appear on the moist bread. This growth is composed of a large number of little mold plants, which turn black after a few days. Molds do considerable damage, although they do not necessarily render foods unfit to

eat. You will remember scraping the layer of mold from cheese, before using it. As a matter of fact, certain cheeses get their flavor from the molds that grow in them. Molds attack other organic materials also and grow on shoes, leather, paper, or even moist wood.

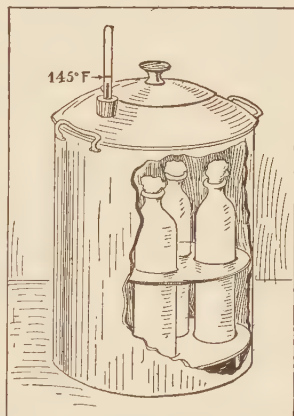
Conditions favorable for the growth of small organisms. — By far the most important enemies of pure foods are the bacteria, which cause decay. Food exposed to the air of the kitchen is much more likely to "go bad" on a warm than on a cool day. Moist foods are decayed more rapidly than dry ones. Boiling or sterilizing kills bacteria and preserves the food for a longer time. Bacteria need air,

also, and darkness is favorable for their rapid growth. Sunlight is one of the best germ killers we have.

Why some foods are more easily spoiled by bacteria than others. — If you select a large number of different kinds of foods and test them to determine in which bacteria grow most rapidly, you find that those which contain moisture, and a large amount of protein, are most favorable for bacterial growth. As bacteria feed on protein, it falls to pieces and eventually rots. No food should be eaten that has a bad odor or an appearance of decay, since these may be evidences of poisons given off by the bacteria as they break down the foods they feed upon.

Pasteurization of milk. — Milk is one of the favorite foods of bacteria and a very important one for children. Since a baby's digestive system is easily upset, we should protect it by having the milk as free from germs as possible.

All raw milk contains germs, even as soon as it is taken from the cow, the most numerous kind being those which cause milk to sour. To kill the harmful bacteria without injuring the milk, a method known as *pasteurization* is used. This process is named after the great French scientist, Louis Pasteur, who applied his knowledge of harmful germs to human betterment. The best method for pasteurizing milk is to keep it at 145° Fahrenheit for



Pasteurizing apparatus, an arrangement by which milk is conveniently heated to destroy disease germs. The thermometer tells the degree of heat used.

at least 30 minutes. Most milk delivered to the city home has been pasteurized, because it keeps sweet longer than unpasteurized milk.

Canning foods. — Canning is a method by which foods are boiled to kill the bacteria in them and placed while hot in vessels into which no more bacteria can gain entrance. This is done usually by boiling fruits or vegetables, sometimes with sugar or salt, placing them immediately in sterile jars and sealing them tight. They may be canned also by placing clean uncooked food in cans, which are boiled for a considerable period of time, and covered while hot. The United States Government, Department of Agriculture, Farmers' Bulletin No. 839 gives full directions for canning by this last method, called the cold-pack process. The main thing to bear in mind is to have the jars as well as the material that goes into them, sterilized, that is, absolutely free from all living matter by heat.

Experiment. — What effect have different preservatives upon bacteria?

Preservatives and their uses. — Foods are protected often by adding substances in which bacteria cannot live and develop. Such materials as salt, sugar, vinegar, and spices are harmless preservatives. In recent years, other substances, such as benzoate of soda, borax, or boracic acid have been used as preservatives, but these are harmful, especially when used in large quantities.

Why foods keep at a low temperature. — Bacteria are prevented from growing in foods which are kept in cold storage from two months to two years or more. But we must remember that intense cold prevents the growth of bacteria, and does not kill them. Cold storage foods,

therefore, if placed in conditions favorable for the growth of germs, will soon spoil.

Demonstration Experiment.—To Show the Principle of Air Circulation in the Refrigerator.

Materials: Cylindrical lamp chimney. Wire gauze. Ring Stand. Ice. Joss stick.

Method: Support the inverted lamp chimney by means of the ring stand. Fix the wire gauze inside near the top. Place a lump of ice, size of a walnut, upon the wire gauze. (a) Hold the smoking Joss stick near the surface of the ice. (b) Hold the Joss at the lower opening of the chimney.

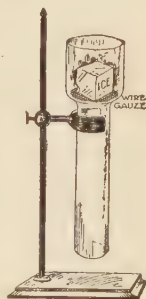
Observations: (a) Does air rise out of the top of the chimney — or does it enter there?

(b) Does air enter the bottom of the chimney? Does it pass out of this end? Make a diagram to show (use arrows) the circulation of air.

Conclusion: Does ice cause movement of the air?

If in doubt test the chimney without the ice. Explain the cause of the air movement.

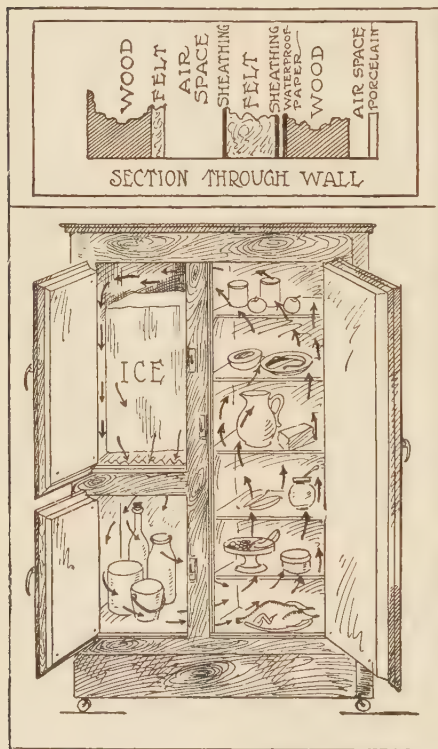
Application: Apply this principle to the circulation of air in the refrigerator.



We have seen that warm, moist air helps germs to grow, and decay to take place. The refrigerator prevents this decay by surrounding foods with dry, cold air. Left-overs which otherwise would be wasted are thus saved for use, and foods and drinks are made more palatable.

Construction of the refrigerator. — The household refrigerator is a large box with thick, heat-insulating walls, and with doors or covers to the several compartments inside. There is always one chamber for the ice, and another with shelves for food. Both of these compartments are connected by ducts or spaces, so that there is a free circulation of air throughout the entire refrigerator.

The drainage pipe leads to a pan, or to a waste pipe, which is protected by a trap that prevents warm air from coming



Circulation of air in the refrigerator. What foods are placed below the ice chamber? Why?

in. The wall is of much importance; one of the best is made of layers as suggested in the diagram. If heat enters this wall, it must go through all of these insulating substances.

How to use the refrigerator. — When air comes in contact with ice, it gives up heat to the ice, becomes colder and heavier, and sinks to the bottom of the ice chamber. An outlet below the ice allows this cold air to pass out at one side to the bottom part of the refrigerator,

where warm food substances give off their heat to the cold air, which is warmed and gradually rises, passing in again at the top of the ice chamber. Thus we have a circulation of air within the ice box.

The warm air, returning to the ice, causes some of it to

melt, and the heat is carried off in the water which drips into a drain outside. Since most foods have more or less odor, we must place those which give off the most odor at the top of the ice chest where the air is warmer, while meats, milk, and butter should be placed in the coldest part of the ice box, where they will not take the odor from other things. If you want your ice box to be cold inside, do not cover the ice with newspapers or a woolen blanket. If you desire to keep the ice, and not the food, this is the way to do it.

Thermos bottle. — The thermos bottle, as a study of the diagram will show, is another application of insulation. It is a double walled bottle or one bottle inside of another, with a vacuum between. A vacuum is a better insulator than air. The inside walls of the bottles surrounding the vacuum are mirrors which reflect radiant heat energy and prevent its passage across the vacuum. Thus the thermos bottle keeps cold substances cold, and hot substances hot, by preventing loss of heat from a hot body and by keeping outside heat away from a cold body.



Section of thermos bottle.
(After Hoadley.)

A clean kitchen necessary. — Since foods are handled in the kitchen, it goes without saying that a clean kitchen will go a long way to prevent spoiling of foods. This means that all surfaces in the kitchen should be washed frequently. Why? Tables and shelves should be covered

with oil cloth or something which can be wiped off and dried quickly. Wooden surfaces, especially when they become greasy, make excellent homes for bacteria. Remember that hands must be kept clean when handling foods. Since flies carry disease the kitchen should be

screened. Dishes should be washed clean with plenty of soap and hot water. The accompanying diagram will illustrate how the clean washing of dishes helps in keeping bacteria from foods.

An excellent method of drying is to stack the dishes on the draining board and then to pour boiling water over them. Why is this better than drying them with a towel? Is it a good plan to leave the dishes to drain overnight? Why not?

NUMBER OF BACTERIA LEFT ON A PLATE
AFTER DIFFERENT METHODS OF WASHING

① 57,000

② 259,000

③ 57,000

④ 36,000

⑤ 10,500

⑥ 5,100

⑦ 5,000

⑧ 1,400

⑨ NONE

1. As plate leaves table. 2. Washed in lukewarm water; not rinsed. 3. Rinsed in lukewarm water after washing. 4. Warm water; not rinsed. 5. Rinsed in warm water after washing. 6. Warm water; rinsed in hot. 7. Washed in hot water; not rinsed. 8. Washed and rinsed in hot water. 9. Washed and rinsed in boiling water.

Hints on the use of this score card. — We are all interested in keeping well and strong. We all like good things to eat, too. Study the conditions in your home, suggested by each item in the score card. Be fair in your marking. The purpose is not to see who can get the highest score but to show each one of you just what conditions surround you and to suggest those things which need correction the most.

SCORE CARD. PURE FOOD IN MY HOME

	EXCELLENT	FAIR	VERY POOR	MY SCORE	
					Total
CLEANLINESS IN THE CARE OF FOOD	Closed closet for dishes — Glass doors (2) Dishes scalded, drained dry (2) Wash hands before handling food (3) Kitchen always kept clean (3)	Closed closet, wooden doors (1) Dishes dried with clean towel (1) Sometimes remember to wash hands (1) Kitchen usually clean (1)	No closet for dishes (o) Dishes not scalded (o) Never wash hands before handling food (o) Kitchen seldom clean (o)	..... ..... ..... .....	
REFRIGERATOR	Large enough (2) Enamel or porcelain lining (2) Economical of ice, (2) Food placed to show knowledge of convection currents (2) Washed thoroughly twice a week (2)	Too small (1) Galvanized iron or zinc interior (1) Wasteful of ice (1) Food in part properly placed. Some foods spoil or taste (1) Washed thoroughly once a week (1)	No refrigerator (o) Rough or cracked interior (o) Does not keep ice or food (o) No knowledge of convection current shown (o) Washed irregularly Has odor (o)	..... ..... ..... ..... .....	
STERILIZATION AND PASTEURIZATION	Left-overs heated to boiling (3) No fruits left to spoil (2) All milk left over scalded (2) Milk for children pasteurized or certified (3)	Some left-overs lost not sterilized (1) Fruit occasionally spoils (1) Some milk scalded (1) No certified milk but supply pasteurized (2)	No left-overs saved (o) Fruit often spoils (o) No milk saved (o) No pasteurized or certified milk (o)	..... ..... ..... .....	
USE OF PRESERVATIVES	Proper knowledge of use of preservatives shown (2) Salt or waterglass used in preserving foods (2) Vegetables and fruits canned (2) Sugar used in preserving fruits (2) No harmful preservatives in bought foods (2)	Some food wasted because of lack of knowledge (1) Salt or waterglass sometimes used in preserving (1) Part of extra supply canned (1) Some fruits and jellies made (1) Use of preservatives in food shown by label (1)	Much food wasted (o) Salted food not used; eggs not preserved (o) None of extra supply canned (o) No jellies or preserves made (o) Preservatives other than salt, sugar, vinegar in food (o)	..... ..... ..... ..... .....	
PROTECTION OF FOODS	Perishable foods kept cool (2) Foods kept covered (2) Canned goods never left in cans after being opened (2) All foods protected from insects (2) Fly screens in windows; no flies in house (2)	Perishable foods sometimes kept cool (1) Foods sometimes covered (1) Canned goods sometimes left in cans (1) Insects sometimes get in foods (1) Fly screens in windows; a few flies in house (1)	Much perishable food wasted (o) Foods often uncovered (o) Canned goods often left in cans after opening (o) Insects often in food (o) No screens; many flies in house (o)	..... ..... ..... ..... .....	
GRAND TOTAL					
PERFECT SCORE 50					

REFERENCE BOOKS

- Allen, *Civics and Health*, Chapter XXV (For teachers). Ginn and Company.
- Broadhurst, *Home and Community Hygiene*, Chapters I, III, IV (Teacher's use). J. B. Lippincott Co.
- Caldwell and Eikenberry, *Elements of General Science*, Chapter VIII. Ginn and Company.
- Clark, *An Introduction to Science*, Chapters IX, XIV. American Book Company.
- Conn, *Bacteria, Yeasts and Molds of the Home*. Ginn and Company.
- Claycomb, *Petri Dish Projects*. School Science and Mathematics, April, 1918.
- The Persistent Delusion of Plomaine Poisoning*. Current Opinion, April, 1918.
- Hunter, *A Civic Biology*, Chapters XI, XXIV. American Book Company.
- Hunter, *Laboratory Problems in Civic Biology*, Chapter XI (For suggested experimental work). American Book Company.
- McNutt, *The Modern Milk Problem* (For teachers). The Macmillan Company.
- Official Handbook*, Boy Scouts of America (Questions on decay). Doubleday, Page and Company.
- Public Health Service Bulletin 56, *Milk and its Relation to Public Health*.
- Ritchie, *Primer of Sanitation*, Chapter XXX. World Book Company.
- Milk*, U. S. Department of Labor, Bulletin 35 — Children's Bureau.
- Van Buskirk and Smith, *The Science of Everyday Life*, Project X. Houghton Mifflin Company.
- Vulte and Vanderbilt, *Food Industries*, Chapter VIII. Chemical Publishing Company.
- Weed, *Chemistry in the Home*, Chapter XXIV. American Book Company.
- Wing, *Milk and Its Products* (For teachers). The Macmillan Company.

CHAPTER VI

HOW WASTES ARE REMOVED FROM THE HOME

Problems. — 1. *To understand how wastes are removed from the body.*

2. *To understand the system of waste removal needed for the home.*

3. *To learn how the various plumbing fixtures work.*

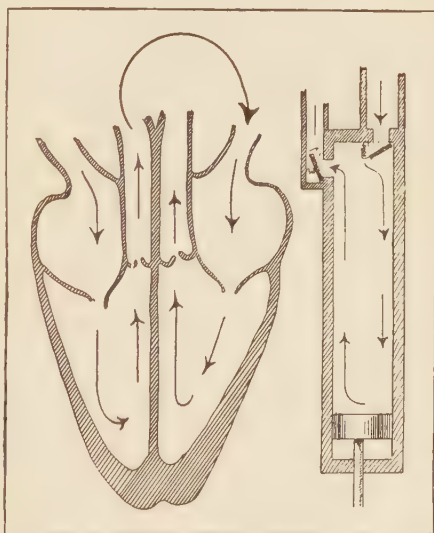
4. *To see how a septic tank does its work.*

5. *To learn how wastes affect the lives of some harmful insects.*

Suggested project. — 16. To prepare myself to keep the home plumbing system in order.

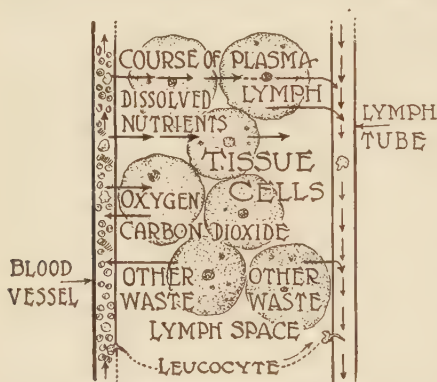
How wastes are removed from the human body.—We

have seen that the human body uses foods wherever work is done in it. After the food is digested it is absorbed by the blood which carries it through a system of pipes



The upper cavities in the heart are called auricles (right and left), the lower, the ventricles (right and left.) Follow the arrows. In what respect is the heart like a force pump?

called *veins* to a pumping station called the *heart*. This is a double station; the left side of it forces the blood through the *arteries* (see page 97) to all parts of the body, while the right side pumps blood to the lungs where it gives up carbon dioxide, and receives oxygen. The arteries divide many times becoming smaller each time until



The exchange between blood and the cells of the body.

they form tiny tubes known as *capillaries* which are near the cells — or little units of building material of which the body is composed. The dissolved food soaks through the thin walls of these capillaries and bathes the cells so that they are continually supplied

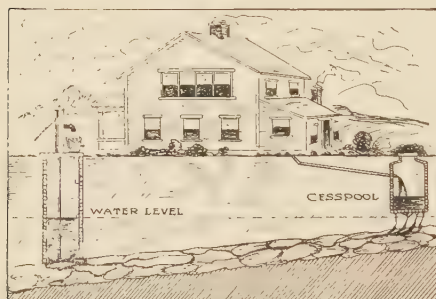
with food. In the cells the heat-producing food is oxidized and energy released, while the food containing nitrogen is used to build and repair the tissues of the body. Nitrogen does not unite easily with oxygen, and hence a considerable amount of nitrogenous material must be passed from the body as waste. This and other waste materials are passed out from the *cells* into the lymph spaces, then into the lymph tubes, and ultimately into *veins*, which are tubes carrying blood toward the heart. Wastes containing nitrogen are collected finally by the kidneys and are passed out of the body through the urine. Other wastes and material which cannot be digested are passed out from the body through the food tube in a

partly decayed condition. This work of decay is carried on by millions of bacteria which live in the lower part of the intestine.

Why we need a system to remove wastes from the home.

— All body wastes as well as garbage, used water, and the like must be removed from our homes and put where they cannot do harm to others. Wastes from the body contain bacteria, possibly harmful ones. As we cannot afford to do anything which will harm others, we must give this matter of the disposal of sewage and wastes our thoughtful attention. Open privies to which flies go may be the means of spreading disease among one's own brothers and sisters. Garbage thrown out and left to decay may mean millions of flies for you and your neighbors. Water and wastes from the kitchen sink allowed to form a dirty, smelling pool outside, may become the breeding place of insects as well as the source of foul odors. The purpose of this chapter is to point out some of the means by which sewage and other wastes are removed from the home and rendered harmless to others. We must remember that sewage and materials containing wastes from the body are very dangerous to health. It has been shown many times that as a result of carelessness, germs pass from sewage into drinking water or get on the food. It is necessary, therefore, that sewage, in cities as well as in the country, be properly disposed of, or else it becomes a menace to health. In 1854 there was a great outbreak of Asiatic cholera in London. Some parts of the city were stricken much more than others. In those days people got their water from wells, and the Broad Street pump had such a reputation for clean, sparkling water, that people from blocks away went to it for their drinking water. It was found, however, that

one of the greatest outbreaks of cholera was among people taking water from this well, so the health authorities investigated the conditions there. Imagine their horror



Why well water is sometimes unsafe.

to find the well water separated by only a single layer of old worn-out bricks from a cesspool which received the waste materials from many cholera patients. As cholera is a disease of the intestines or bowels

millions of germs were being placed in that well water every day. After the well was closed to the public, the epidemic subsided in that part of the city. This is only one instance among many where germs in the water supply have done untold harm.

The need of sanitary plumbing. — In these days it is hardly necessary for people to have outdoor unsanitary privies. If an outdoor privy is necessary, all parts should be carefully screened to prevent flies from getting in, and the lids of the seats should be close-fitting. Earth mixed with lime should be used constantly to keep the waste material in the receiving vault covered so that flies cannot get to it. In most homes nowadays it is possible to have indoor toilets and pass the waste material along with the kitchen and other wastes into an underground sewer in cities and into cesspools or septic tanks in the country.

The modern bathroom. — A bathroom, furnished with all the necessary fixtures, is shown in the illustration; in

it are a washbasin, bathtub, mirror, cupboard, towel racks, stool, and toilet. Not very many years ago it was thought proper to cover all the plumbing with wood, but this is unsanitary, because it makes an excellent place for germs to lodge and grow. Now bathrooms are furnished with one-piece sanitary bowls, and with tubs made either of porcelain or metal, and with everything raised from the floor, so that all parts are easy to get at in case of repair. A little knowledge of a few



A modern bathroom.

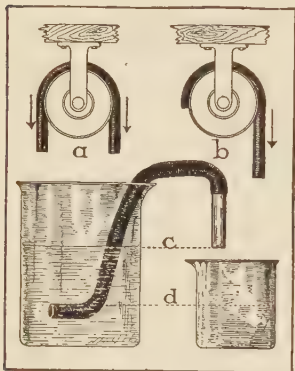
scientific principles underlying the operation of these fixtures will be useful for us to have, and may save much expense and trouble.

Demonstration Experiment. — To See How the Siphon Works.

Materials: Battery jar. Glass beaker. Rubber tube. Glass tube. Pulley with little friction. Cord or rope to go over the pulley.

Method: A. (a) Hang a short heavy cord or small rope over the easily running pulley with the two ends at the same level. See figure a. (b) Change the cord so that one end hangs 6 inches or more lower than the other side. See figure b. B. Connect a six-inch length of glass tubing to one end of the rubber tube. Fill the entire glass and rubber tube with water. Hold the finger over the end of the glass and put the end of the rubber tube into a jar of water. Hold the end of the glass tube just below the level of the water in the jar, and open it. (c) Carefully raise the tube until the end is just level with the water

surface in the jar. See figure *c*. (*d*) Lower the end of the glass tube so that it is several inches below the level of the water in the jar to *d* in figure.



Observations:

A. What happens in cases (*a*) and (*b*)?

B. What happens in (*c*) and (*d*)?

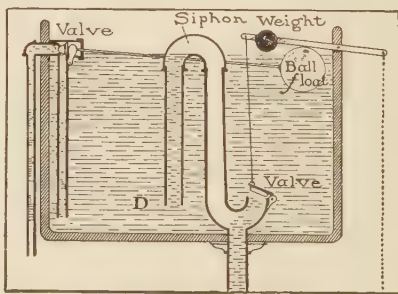
What will happen if the outside end of the tube is raised above the level of the water in the jar? Try it to verify your answer.

Conclusion: The tube is used in this experiment as a siphon. Explain how much of the action of the siphon depends on the pressure of the atmosphere. Why is it necessary to fill the tube with water to start the action of the siphon? How does the

analogy with the rope help to explain a part of the action of the siphon?

Application: Do you make use of the principle of the siphon in your home water supply or plumbing? If so, how?

A flush tank. — If you examine the diagram accompanying this paragraph carefully, you will find that water flows into the tank through the action of the ball float, which, when the toilet is flushed and the surface of the water lowered, opens a valve and allows a new supply of water to come into the tank. When



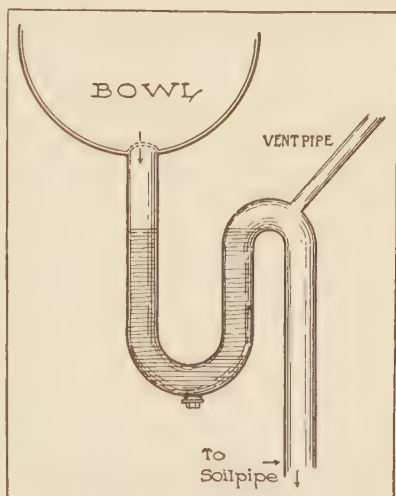
The bathroom flush tank.

the water reaches a certain level the float automatically closes the valve. The toilet itself is flushed by pulling a

lever which opens the valve at the base of the siphon. As the water begins to flow this valve closes, and the water in the pipe leading to the toilet acts as the plunger of a piston (see diagram) and water is passed into the flush pipe through the siphon. As soon as the water in the tank is lowered to the point D the siphon tube fills with air and the action stops. The tank then fills up as has been shown previously.

Experiment. — To understand how the flush tank works.

The home system of drain pipes. — In order to get water and wastes out of the house it is necessary to have a system of drain pipes including a large *soil pipe* which extends from cellar to roof. As all the sinks, toilets, and tubs must connect with this soil pipe, it is necessary to arrange a house so as to have all of the fixtures grouped around it. The pipe must leave the house at a point where it is slightly lower than at any other place, and all pipes leaving fixtures must run slightly down hill also. The large and straight pipes are usually iron with the joints tightly closed by means of cement substances, while the smaller pipes are usually lead. In order to prevent odors



An S-trap showing water seal and vent.

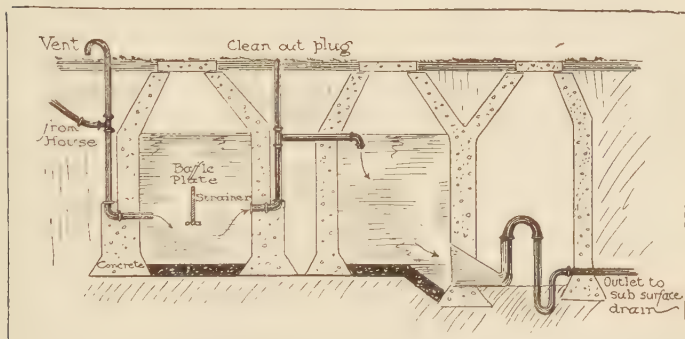
from decaying substances or sewer gas from getting into the house, fixtures known as *traps* are necessary. A study of the figure on page 103 shows that the trap is an inverted siphon, and forms a *water seal* which prevents any gas from escaping. In the water seal or traps, the *vent* (see figure) is usually necessary to keep the air pressure equal on each side of the trap, so that all the water will not be sucked out, leaving no protection against odors.

Under the kitchen sink we often find a grease trap. This is fitted, as are all other traps, with a cap which can be unscrewed to remove the grease which otherwise might clog the drain pipes.

Disposal of sewage. — Where there is no city sewage system the disposal of sewage is a most important question. In places where no proper provision is made, we find sewage running into open drains, or even on the surface, where it becomes a dangerous menace to health. Most country homes nowadays have a *cesspool*, or a deep hole dug in the earth, with an open bottom, uncemented rock or brick walls and a covered top. It is usually situated a few feet away from the house, and receives all the sewage which drains out gradually into the surrounding soil through holes at the sides and bottom. In clayey soils cesspools give much trouble, as little drainage takes place, and it is necessary to pump them out frequently. A cesspool should be simply a *temporary* means of getting rid of sewage.

The septic tank. — By far the most modern and hygienic method of sewage disposal is by means of the *septic tank*. It has been discovered that there are two types of bacteria, one of which (*anaërobic*) thrives without air, releasing oxygen from the substances on which it feeds, and

another (*aërobic*) that must have air. The septic tank is made with at least two compartments, both of which are made of cement and are water-tight. In the first compartment sewage flows from the house, and is attacked by the anaërobic bacteria, which cause the solid matter to become liquid. Fats and other substances rise to the surface, forming an almost air-tight scum, which assists



A septic tank.

the anaërobic bacteria to do their work more effectively. As the sewage is decomposed it passes into the second tank in an almost colorless and odorless condition. When this tank fills, its contents are siphoned off into drains under the surface of the ground. This sewage is now quite harmless, as all organic matter has been decomposed by the bacteria. The liquid leaving the septic tank contains much valuable fertilizing material, and is generally used on the home garden.

Manure and flies. — One of the greatest pests of the average home is the housefly. Not only is it disgusting in its habits of walking over filth and then over food, but it also is a menace to health because it carries the germs of

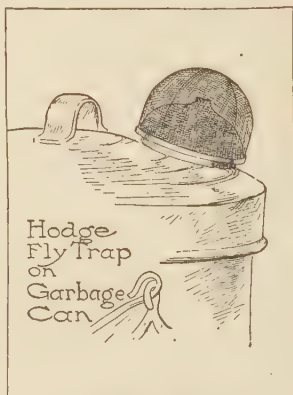
disease. When we realize that perhaps 90% of all houseflies breed in manure heaps we can see the harm of having them near our homes. In warm weather the housefly



Manure piles near a home are a menace to health.

passes through its complete life history and becomes an adult in ten days. A manure heap that is unturned in hot weather may become literally alive with innumerable maggots which are the *larvae* of the fly. It has been estimated that within three months the offspring from one fly would amount to 143,675 bushels of flies. If these figures are correct, it is evident that "swatting the fly" or using screens will not do much good unless the flies are "swatted" early in the season when there are only a few which have lived through the winter. It is a good plan to destroy the breeding places of flies and to trap as many as possible. All manure heaps should be worked over and scattered at least once every ten days so that the flies cannot have a chance to breed. Garbage and any material that might form a breeding place should be carefully removed

passes through its complete life history and becomes an adult in ten days. A manure heap that is unturned in hot weather may become literally alive with innumerable maggots which are



Hodge's flytrap.

within the ten-day period. One of the best poisons for flies is made by adding two tablespoonfuls of formaldehyde to a pint of milk and water. Pour some of this over a piece of bread in a shallow dish and leave it where the flies can get at it. An excellent home project would be the manufacture of an efficient flytrap. The United States Government bulletins, for example, Farmers' Bulletin No. 927, or Hodge's *Nature Study and Life*, give descriptions of excellent traps.

Standing water in relation to mosquitoes. — Another waste which may mean much annoyance and a possible danger to health is standing water. Water standing in open barrels, drains or ditches, leaders or flat roofs, even in the tin cans or broken crockery of a rubbish heap, is a possible breeding place of mosquitoes. We should make it our business to clean up all of the breeding places of these pests in our neighborhood. If it is impossible to get rid of standing water, a covering of crude oil poured over it every two or three weeks will kill the young mosquitoes. Mosquitoes lay their eggs in standing water in warm weather. These eggs hatch within a few hours, the young passing through the "wiggler" and pupa stages and become adult mosquitoes within two weeks' time.

Sanitary garbage pails and their care. — Flies feed on garbage and lay their eggs in the refuse in open garbage pails and elsewhere. The garbage pail should be of metal so that it can be scalded easily and should have a tight-fitting cover. During the summer it should be emptied every day or two, as otherwise the bacteria of decay will cause the refuse contained in it to smell bad. If the garbage is not taken up by a collector, it ought to be either burned or buried so deep that the flies cannot get at it.

On a farm all the fresh garbage should be fed to the pigs or chickens daily. The pail should be kept covered in an inconspicuous place and sterilized with boiling water and washing soda at least twice a week during the hot weather.

REFERENCE BOOKS

Broadhurst, *Home and Community Hygiene*, Chapter VII (Teacher's use). J. B. Lippincott Company.

Butler, *Household Physics*, pages 356-364. Whitcomb and Barrows.

Caldwell and Eikenberry, *General Science*, Chapter XIV. Ginn and Company.

Chapin, *Sources and Modes of Infection* (Advanced and teacher's use) John Wiley and Sons.

Hunter, *A Civic Biology*, Chapters XXII, XXIV. American Book Company.

Lynde, *Physics of the Household*, Chapter VII. The Macmillan Company.

Winslow, *Healthy Living*, Chapter XII. Charles E. Merrill Company.

CHAPTER VII

GERM DANGERS AND HEALTH HABITS

Problems. — 1. *To understand the relation of bacteria to disease.*

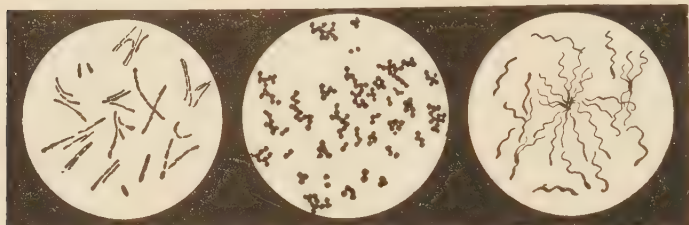
2. *To find out how our body defends itself against germs.*
3. *To see how habits control our health.*
4. *To learn good health habits.*

Suggested project. — 17. To form correct health habits.

Where germs live and how they grow. — Germs, man's invisible friends and foes, have been said by one biologist to exist "anywhere but not everywhere." We know that they cannot live in boiling water or in fire but they swarm in soils, in impure water, in stale milk, in the dead bodies of plants and animals and to a certain extent in living bodies also. They cause decay, and infectious or "catching" diseases. The world loses the time and energy of a very large part of its population each year because of them and yet we cannot exist without them. They are man's invisible friends and foes; without them the earth's crops would be insufficient, and yet some destroy our crops. Some of the later paragraphs of this book will explain these apparently contradictory statements.

What bacteria look like. — It is easy to see the effect of bacteria on milk when it sours and on food when it decays, or to observe colonies of them growing in a Petri dish, yet each bacterium is so small that it is visible only under a very high power microscope. Bacteria are one-

celled plants, unable to make their own food, and consequently do much harm by living at the expense of other things, as upon dead organic material. Some one has said that in order to recall their forms one must think of a



Types of bacteria. 1. Rods. 2. Spheres. 3. Spirals.

billiard cue, a billiard ball, and a corkscrew. A glance at the illustration will show how true this statement is. Bacteria are rodlike (called *bacillus*), ball-like (called *coccus*), or spiral (named *spirillum*) in form. Many kinds can move with great speed through the water by means of tiny, living, threadlike structures which vibrate rapidly. Bacteria never thrive except in moisture, although some of them may be dried and float around in the air without dying, becoming active again when they reach moisture. Many



Bacteria forming spores. forms endure an unfavorable environment of heat and cold as well as dryness by forming a thick resistant coat about their body. In this condition they are called *spores* and may resist boiling even for short periods of time.

Experiment. — To show how infection takes place.

How disease germs get into the body. — It has been estimated that over fifty per cent of the people who die

each year are killed by bacteria. A very large portion of these infectious diseases might be prevented if people knew more about the ways in which germs enter the body and were careful to keep them out.

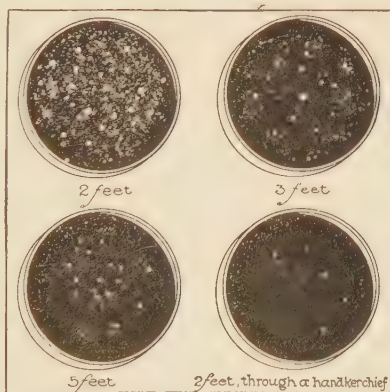
Demonstration Experiment. — To discover the distance germs may be scattered by the “droplet method of infection.”

Materials: Four Petri dishes with sterile agar.

Method: Cough into one dish of agar at a distance of 2 feet, into a second at 3 feet, and into a third at 5 feet. Hold a fourth dish 2 feet away but cough into a clean handkerchief. Cover the dishes and leave them in a warm dark place for several days. Examine them to see which has developed the greater number of colonies of bacteria.

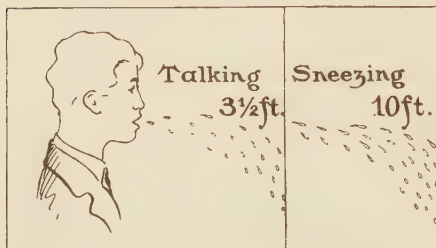
Result and Conclusion: What is the result in each case? What dangers are there from the “coughs” of people having colds and throat diseases?

Application: How can the spread of disease by coughing be greatly reduced?



Germs enter our bodies through the nose, mouth, or a break in the skin. They may be carried by means of food, or water, or pass through the air, and are taken usually directly from a person who has the disease. The most common method of spreading disease is by sneezing or coughing, or even breathing or talking close to the face of some one else. If you have ever watched a person talk when in the sunshine, you may have observed a constant spray of tiny droplets which are forced out from the mouth and thrown into the air for two to three feet. Most “catching” diseases of children begin with sore throat, sneezing, and

coughing. Measles, whooping cough, scarlet fever, tonsillitis, influenza, and diphtheria all begin in this way, hence it is very easy for any one who is beginning to be ill with one of these diseases to spray out the germs, and to infect others. A good



A common method of spreading germs. (After Winslow.)

health habit to form very early in life is that of the proper use of the handkerchief. Never cough or sneeze into the open air, but into a handkerchief.

Keep the nose well

blown to prevent an unpleasant appearance as well as possible spread of colds. A "common cold" soon becomes everybody's cold in a schoolroom in which the children do not have the proper health habits. When one has a bad cold it is a good plan to remain quietly at home resting in bed, for thus one does not scatter the germs and by rest and proper food it will soon be cured.

Disinfectants. — Sometimes it becomes necessary to destroy the bacteria which cause disease in our homes by the use of disinfectants. Many different substances which kill bacteria, such as carbolic acid, lysol, bichloride of mercury, and formaldehyde, are deadly poisons. We must therefore exercise the greatest care in their use. For disinfecting wounds or cuts iodine is much used; while for use on hands, a weak (1 to 25 parts water) solution of carbolic acid followed by washing with green soap is safe and sure.

Our body defenses against disease. — Disease germs

either destroy tissues in the body or give off dangerous *toxins* which act upon the individual in a manner similar to snake venom. Some people are very much more resistant to disease germs than others, and therefore are less likely to take "catching diseases." This resistance to or defense against disease, when powerful enough to kill the germs or offset the harm from toxins, produces an *immunity*. Immunity may be natural, or it may be acquired as in the case of diphtheria by means of *antitoxin* treatment, or as in the case of smallpox and typhoid, by means of *vaccination*. Natural immunity may be increased by improving one's general health.

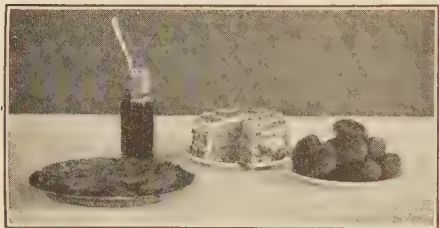
Air and health. — We have already referred to the need of oxygen. It is generally agreed at the present time that we must have as much fresh air as possible, well ventilated rooms, and wear porous clothes so that the skin all over the body will have a constant air bath. We depend upon outdoor play and outdoor sleeping as a means of good health. Morning exercise with the windows thrown open will assist one to acquire a good posture and habits of breathing. Remember that the lungs need exercise and air, and that only by deep breathing which expels much of the stagnant air in the lungs can we make them resistant to disease germs.

Food and health. — We have already learned the amount and the proportions of the different nutrients needed to keep in good physical condition. Boys and girls should eat enough, but not too much, as it is bad to overload the digestive and excretory systems. The improper use of foods when young lays the foundation of illness in later life. We should not eat when very tired, nor between meals, and should have only a light meal at night. Hard

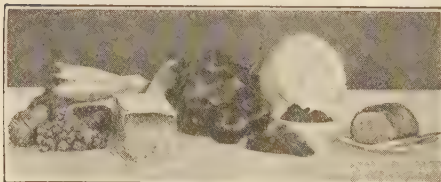
and bulky foods should be included in the menu, since they tend to prevent constipation. Raw foods containing vitamins should always be a part of the diet, especially uncooked milk, fresh fruits, and fresh vegetables. Fruits



Simple foods are nourishing.



Indigestible foods.



(Eastman Kodak Co.)

Bulky foods.

and vegetables if eaten raw should be carefully washed in clean water to prevent the danger from disease germs.

Care of the teeth.

— Thorough chewing of the food is necessary to good health. Many of us bolt our food, and as a result suffer from indigestion. As good teeth are necessary for chewing food properly, care must be taken to prevent their decay. The teeth and the gums around them should be brushed at least

twice a day. Brushing up and down is of much more value than across because it dislodges the food particles held between the teeth, and thus prevents their decay. The teeth should be examined by a dentist at least twice a year and cavities filled to prevent pain and possible loss

later. Decay of the teeth is a result of bacteria which lodge in the same crevices with the food and produce an acid waste substance. This attacks the hard enamel of the teeth, breaking it down and making a cavity into which germs enter and attack the living portion of the teeth underneath. Upon our teeth depends much of our



Results of care and neglect of teeth.

health later in life, therefore let us form habits of proper care of them while we are young.

Body poisons and good health. — One of the best habits to get early in life is that of regularity of bowel movement for thus we may be spared the evils which come through constipation. As we have learned before, the lower part of the food tube, if not emptied regularly, becomes filled with decaying material, caused by the millions of bacteria which live there. As this decay takes place, the soluble poisons set free are easily passed through the walls of the bowels and get into the blood, causing a headache and a feeling of discomfort which often attend constipation. Excellent suggestions which will help to fight this evil are the following: Drink a glass of water



Drink six glasses of water a day.

when you get up in the morning, and at least one glass before each meal. Raw or cooked fruits, green vegetables, whole wheat bread, bran muffins, fats, and oils are helpful in keeping the bowels regular. Avoidance of tea and coffee, and proper hours of sleep, all help in overcoming this evil.

Exercise and health. — Most boys and girls may exercise enough, but often it is not done properly. In the case of girls, especially, proper posture, or poise of the body, in walking, sitting, and standing, is very important. The bad habit of sprawling over the desk or table when at work makes round-shouldered, small-chested men and women. Learn to keep the shoulders square and back, keep the chest high and out, and both the stomach and chin in. Military training is of great assistance in gaining a proper posture. Games such as baseball, volley ball and tennis not only mean good times but trained muscles and nerves also. An erect carriage enables you to look the world in the face, and helps you to smile in the presence of hardship or danger.

Home duties. — Every boy and girl should have a part in the duties as well as the pleasures of the home. It is unfair to mother and father to have them assume all the care of the house, and the younger members of the household should be trained to have a practical knowledge of how the house is made to run smoothly. Besides this, there is a certain amount of healthful exercise in weeding the garden or cleaning the walk or bringing up the coal or running a sewing machine or a churn. The score card on page 117 will give you some idea of how well you are living up to your part of the home duties.

SCORE CARD. HOME DUTIES OF CHILDREN

MY OWN RECORD	TIME. MIN-UTES PER DAY	SCORE
1. Sweeping and dusting general rooms		
2. Full charge of own chamber		
3. Making beds		
4. Helping cook		
5. Ironing		
6. Preparing wood and kindling		
7. Building fire regularly		
8. Taking care of furnace		
9. Taking care of hens and chickens		
10. Tending baby		
11. Taking care of a pet: dog, cat, bird, fish, or rabbit		
12. Taking care of garden and lawn		
13. Shoveling paths		
14. Setting tables		
15. Washing dishes, running errands		
16. Other work		
TOTAL		

Copy this form of record in notebook.

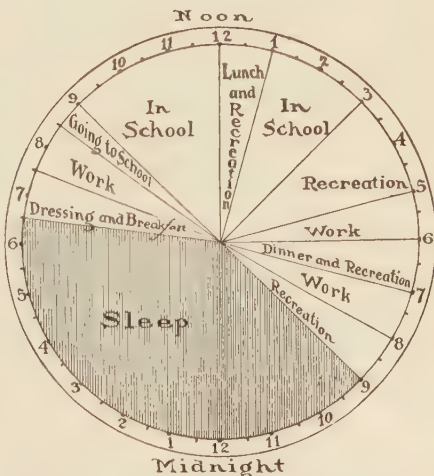
Register average time per day given to work here listed.

A total of 10 points for every 15 minutes devoted to any duty daily.

Boys and girls will score extra work not mentioned here under 16. No score allowed over 100. Two and one half hours daily home work outside of school work entitles you to a perfect score.

Rest and health.

— Our days should be made up of work and play, rest and sleep. It is just as harmful to over-exercise, as it is to under-exercise. One should remember that all machines need rest, and the human machine is no exception to the rule. At least eight hours of sleep should



This is one pupil's daily program for five days a week.

be secured by every boy and girl of high school age, and nine or ten hours of sleep by younger children. Fewer movies and more quiet reading at home would be good for the average boy and girl. Moderation in all things is a good rule. Overstrain of any kind brings on fatigue, and shows that we cannot strain an organ without paying for it in the end. If we overstrain the eyes, for example, we pay for it by wearing glasses later. If we overstrain



Always wash the hands before eating.

(Eastman Kodak Co.)

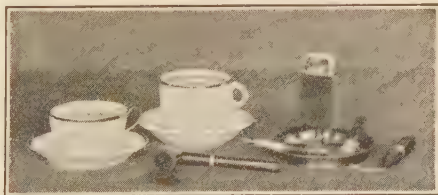
in athletics, we may have to give them up altogether. Over-fatigue by keeping too late hours will surely call us to account later in life. Let us learn the value of complete relaxation, and let us get the habit of going to bed at the proper hour while we are growing.

Habits of cleanliness. — “Cleanliness is next to godliness” is an old saying, and a good one. Habits of cleanliness at meals and in preparing food are particularly

necessary. One should always wash the hands upon leaving the toilet. The entire body should be bathed at least twice a week always, and every day in warm weather to remove perspiration.

Not only should we get the habit of cleanliness of body, but we should strive for cleanliness of mind also. We should learn to keep watch upon our thoughts as well as upon our bodies, for purity of mind as much as purity of body will have a good effect on health as well as a good influence over others.

The use and abuse of drugs. — One degrading habit to which Americans are addicted is the use of patent medicines and drugs. American newspapers receive annually fully \$40,000,000 for advertising patent medicines; how much more must the manufacturers of these medicines receive? It should be a rule never to use a medicine unless it is prescribed by a reliable physician. The body is a delicate machine, and easily put out of running condition. If it is out of order a physician should be consulted, as it is not always safe to "doctor" oneself. Boys and girls should not drink tea and coffee. Cocoa and milk are better beverages, as they contain food substances; while tea and coffee have no food value and are dangerous because they are stimulating and habit forming. It goes without saying that alcohol in any form should not be used. Tobacco has been proved to have a bad effect upon growing boys. Dr. Seaver of the physical



Tea, coffee, and tobacco are especially harmful during the years of bodily growth.

It goes without saying that alcohol in any form should not be used. Tobacco has been proved to have a bad effect upon growing boys. Dr. Seaver of the physical

training department of Yale College some years ago made a careful comparison of the growth of smokers and non-smokers during their four years in college. He found that students who did not use tobacco gained ten per cent more in weight, twenty-four per cent more in height, twenty-seven per cent more in chest expansion, and seventy-seven per cent more in lung capacity than did the smokers. The tobacco heart of smokers is well known to the athlete, and no boy who is in training can have any doubt that the use of tobacco has a bad effect on his "wind."

Fifteen health rules. — One of the most interesting and helpful books written in late years is the manual, *How to Live*, by Professor Irving Fisher and Dr. E. L. Fisk. They summarize the health habits given in this chapter in the following fifteen rules:

I. AIR:

1. Ventilate every room you occupy.
2. Wear light, loose, and porous clothes.
3. Seek out-of-door occupations and recreations.
4. Sleep out of doors, if you can.
5. Breathe deeply.

II. FOOD:

6. Avoid overeating.
7. Eat sparingly of meats and eggs.
8. Eat some hard, some bulky, some raw foods.
9. Eat slowly.

III. POISONS:

10. Move the bowels regularly and frequently.
11. Stand, sit, and walk erect.
12. Do not allow poisons and infections to enter the body.
13. Keep the teeth, gums, and tongue clean.

IV. ACTIVITY:

14. Work, play, rest, and sleep in moderation.
15. Keep happy.

How to score my health habits. — Everyday life is nothing but a repetition of things over and over again until they become habitual. One great thinker and teacher has said that we are “bundles of habits.” Certainly our daily routine should be largely a matter of habits and of *good* habits. Therefore we should make no score whatever unless each point mentioned has become a matter of habit. There ought to be a good many points that you can add to this score card, some of which may be of more importance than the ones on the card. Be sure to add these and bring them to class for discussion. Perhaps by all working together you can make an ideal card, much better than the one which follows.

SCORE CARD. PERSONAL HEALTH HABITS

	PERFECT SCORE	MY SCORE
Regular daily routine	5	
Setting-up drill and deep breathing	5	
Cool rub or shower	5	
Teeth brushed morning and night	5	
Slow eating at meals	5	
Food chewed well	5	
No overeating	5	
Cheerfulness at meals	5	
Regular toilet habits	5	
Wash hands often, always after toilet	5	
Clean shoes and clean linen	5	
Loose, comfortable clothing	5	
Feet warm and dry	5	
Regular play hours	5	
Exercise in open air two hours a day	5	
Regular work and study hours (at least two hours)	5	
Proper lighting for study	5	
Bed before 10 P.M.	5	
Sleep in open air or with windows open top and bottom	5	
No coffee, tea, or cigarettes	5	
TOTAL	100	

SCORE CARD. PROTECTION AGAINST DISEASE

	PERFECT SCORE	MY SCORE
Vaccinated for smallpox	5	
Teeth examined twice a year	5	
All cavities filled	5	
Eyes examined once a year	5	
Glasses used when necessary	5	
Keep more than five feet distant from those who cough or sneeze	5	
Take care to use handkerchief if you cough or sneeze	5	
Stay in the house if you have a cold	5	
All clothing clean and sterile at all times	5	
Wounds properly disinfected	5	
TOTAL	50	

REFERENCE BOOKS

- Adams, *The Great American Fraud*. American Medical Association.
- Broadhurst, *Home and Community Hygiene*, Chapter X (Teacher's use). J. B. Lippincott Company.
- Brownell, *General Science*, Chapter III. Blakiston's Son and Company.
- Chapin, *Sources and Modes of Infection* (Teacher's use). John Wiley and Sons.
- Clark, *An Introduction to Science*, Chapter XX. American Book Company.
- Conn, *Bacteria, Yeasts and Molds of the Home*. Ginn and Company.
- Conn, *Story of Germ Life*. D. Appleton and Company.
- Dakin and Dunham, *Handbook of Antiseptics* (Advanced). The Macmillan Company.
- Dorset, *Some Common Disinfectants*. Farmers' Bulletin 926.
- Fisher and Fisk, *How to Live*. Funk and Wagnalls.
- Harmfulness of Headache Mixtures*. Farmers' Bulletin No. 377.
- Habit-Forming Agents*. Farmers' Bulletin No. 393.
- Hill, *The New Public Health* (Teacher's use). The Macmillan Company.
- Hunter, *A Civic Biology*, Chapters XI, XXIV. American Book Company.
- Hunter, *Laboratory Problems in Civic Biology*, Chapter XI. American Book Company.
- Jewett, *Good Health*. Ginn and Company.
- Lee, *Health and Disease* (For teachers). Little, Brown, and Co.
- Prudden, *Dust and its Dangers*. G. P. Putnam's Sons.
- Ritchie, *Primer of Sanitation*, Chapters XXXI, XXXII. World Book Company.
- Van Buskirk and Smith, *The Science of Everyday Life*, Project IV. Houghton Mifflin Company.
- Winslow, *Healthy Living*. Charles E. Merrill Company.
- Zinsser, *Infection and Immunity* (For teachers). The Macmillan Company.

PART III. HEAT IN THE HOME

CHAPTER VIII

FUEL AND HEAT

Problems. — 1. *To learn about fuels and their relative values.*

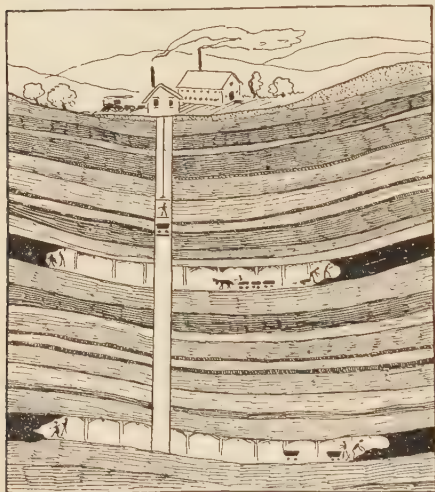
2. *To find out what burns in fuels.*
3. *To learn the difference between "heat" and "temperature."*
4. *What is the kindling temperature?*
5. *How is heat transferred?*
6. *To understand how the body loses heat.*
7. *To learn what is proper clothing.*

Suggested projects. — 18. To make a house thermometer.
19. To find out of what materials clothes are made.

Food and fuels. — We have already seen that certain foods, such as fats and carbohydrates, are fuels for the body and they could be burned in a stove or furnace as well, for does not grease take fire and toast burn? Evidently fuels for the body have the general characteristics of those that are to be considered in this chapter.

Sources of fuel. — Coal, gas, oil, wood, and alcohol are the materials used commonly as fuels. Most fuels come from plants originally, that is, they are organic in origin. Coal, which seems like rock, is really nothing more or less

than plants which were buried long ago and have gradually been changed into the material we burn. Prints of leaves and sometimes whole trees transformed into coal are found in coal mines. Specimens of such formations may be seen



Coal beds in the earth.

in our museums.

Millions of years ago vegetation collected in swamps, sank into the earth, and by changes in the earth's surface was covered with soil. Then pressure, heat, and moisture acted together on this plant material, gradually driving off some of it as gases and leaving a hard substance made up very largely of *carbon*. In

some places similar swamps exist now and are called peat bogs, a poor kind of fuel being dug from them, which, after drying, may take the place of coal or wood.

Heating value of fuels. — Although most of us in large cities use coal or gas for heating and cooking, wood is the fuel most used in all parts of the world. The time is coming when coal and natural gas, which is used for heat and light in regions where it is abundant, will be exhausted. Then we shall have to fall back on the "white coal" of the mountain stream, the power of which is turned into electricity. It is of some interest to compare the available

heat produced by different fuels and the price of each. In the following table is shown the amount of water which can be heated from the freezing point to the boiling point for one cent at specified prices, provided *no heat is lost*. It is understood, of course, that no heating device will give one hundred per cent efficiency in the burning of fuel, so that, in practice, you could not heat as much water to the boiling point as indicated by the table at the bottom of this page.



In an oil region.

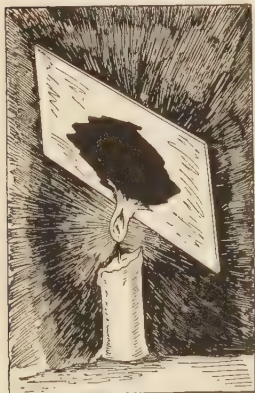
If you wish to heat only a kettle full of water, the coal range gives much less efficient service than the gas range,

QUANTITIES OF HEAT OBTAINED FROM VARIOUS FUELS FOR
ONE CENT

FUEL	PRICE	Gallons of water heated from freezing to boiling point if <i>no heat is lost.</i>
Soft wood	\$15.00 per cord	14
Hard wood	16.00 per cord	20
Soft coal	10.00 per ton	17
Hard coal	15.00 per ton	13
Coke	12.00 per ton	13
Charcoal	80.00 per ton	2.6
Kerosene	.20 per gal.	4.1
Natural gas	.50 per 1000 cu. ft.	13
Manufactured gas	1.50 per 1000 cu. ft.	2.8

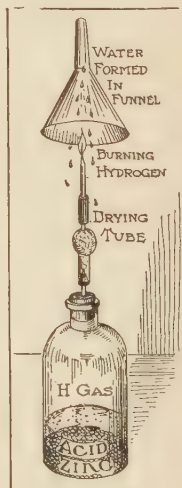
even though gas may cost more for a given number of heat units.

Experiment.—To determine what it is in fuels that burns.



Carbon from a candle.

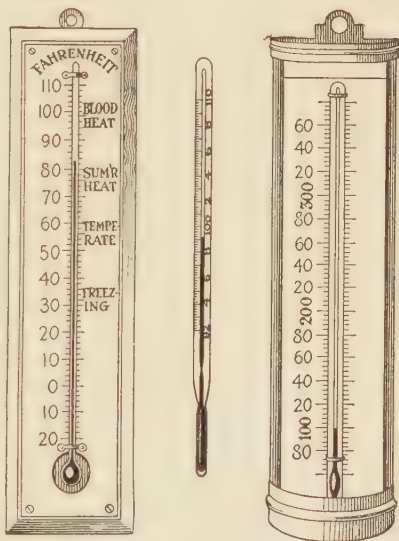
What is it that burns in fuels? — If you hold a clean glass plate in the flame of a candle, you will notice a thick, black deposit gather on that part of the plate exposed to the flame. This material comes from the candle and is almost pure carbon. If we hold a well-dried funnel over the candle flame, we find drops of moisture appear on the inside of the funnel. We know the water did not come from the air, because no water settled on the walls of the funnel before the candle was placed under it, therefore we conclude that a burning candle produces water. If we now make some hydrogen gas by pouring a little hydrochloric acid over zinc, and then pass it through a drying tube as shown in the diagram, we can burn the gas in air. Let us first allow it to pass for two or three minutes into a dry, cold funnel. Watch the inside of the funnel carefully. Does anything happen? Now light the colorless gas and invert the funnel over the flame as before. You will notice that water appears on the inside of the funnel. Hydrogen cannot be



Water is a product of burning hydrogen.

separated into anything simpler in composition, but the candle is composed of a number of different things. Since water is formed both by the burning of the candle and the burning of hydrogen, it seems probable that hydrogen is in the candle also. All fuels contain carbon and most fuels contain hydrogen, and many contain other chemical elements in addition.

How temperature is measured. — What do we mean by temperature? We know that our bodies are warm, and that ice is cold. We have an instrument called the thermometer which measures intensity of heat in units called degrees. This is commonly made of a fine bore sealed glass tube which is expanded at the lower end into a bulb which is filled with mercury or colored alcohol. Since heat makes these substances expand they rise in the small bore of the tube as they get warmer and indicate degrees of heat, which have been marked on the glass tube. There are two kinds of measurements, the one used by scientists, known as the Centigrade scale, and the Fahrenheit scale used in this country for ordinary purposes. Thermometers are useful as regulating devices in cooking,

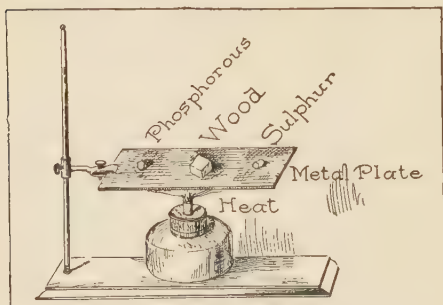


Three types of thermometers. The "weather" and clinical thermometers use the Fahrenheit scale. The "candy" (right) uses the Centigrade scale.

so we often find them placed in oven doors of cookstoves. We also use them in keeping the temperature of our living rooms at an even temperature of about 70° Fahrenheit. The clinical thermometer has become a household necessity, as it is used in order to detect any change in the temperature of the body from normal, or 98.6 degrees. Changes in the body temperature are the surest indication that something is wrong within. Fever always shows the presence of toxins or poisons in the blood, and may indicate a serious illness. In case of a high temperature a physician should always be called and the patient kept in bed.

Demonstration Experiment. — To Compare Kindling Temperatures.

Materials: Tin plate or sheet iron. Sulphur. Phosphorus. Wood. Ring stand. Clamp. Burner.



Method: Support the sheet iron horizontally with a clamp attached to ring stand. Place a small block of wood or some broken match stems on the middle of the iron plate, and two inches distant from this place on one side a lump of sulphur the size of a

pea, and on the other side a piece of phosphorus the size of a rice grain. (Do not handle phosphorus with the bare hands and always cut it under water.) Place a low flame under the middle of the iron. The iron distributes the heat so quickly that we may assume that all the materials are being warmed equally at the same time. Each time one burns we may turn the heat on a little stronger.

Observations: Note the appearance of smoke, the melting of the substances, and the order of taking fire.

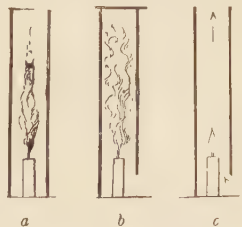
Conclusion: The temperature at which a substance takes fire is known as the kindling temperature. What does this experiment show

you in regard to kindling temperatures of sulphur, phosphorus, and wood?

Application. Apply this principle (a) to the construction of a match and (b) to the method of building a coal fire.

The kindling temperature. — It is evident that different substances take fire at different intensities of heat. The intensity or degree of heat is called *temperature*. In the experiment described above we find that the phosphorus burns first, then the sulphur, and a much higher temperature is necessary to make the wood burn. Evidently some substances kindle at a much lower intensity of heat than others.

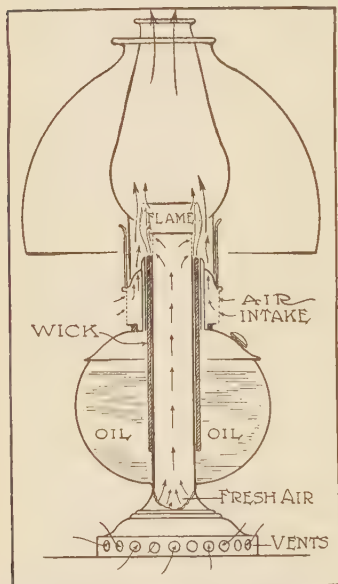
Study of a match. — Fire making has improved greatly since the days when the Indian rubbed a pointed stick in a hole in another stick in order to obtain a fire through the heat evolved by the rapid rubbing or friction. The flint and steel of our forefathers made use of percussion in obtaining fire, and the modern friction match makes scientific use of the different kindling temperatures of different substances. Phosphorus kindles at a lower temperature than most substances, but white phosphorus is poisonous and its use in making matches has been prohibited by law. The ordinary match head contains a mixture of a phosphorus compound combined with potassium chlorate, powdered glass or sand, and glue. By rubbing this against a rough surface enough heat develops so that it lights. In the safety match the head is made of a substance that burns at a low temperature while red



a, No air inlet; b, No air outlet; c, Has both inlet and outlet. This gives a good draft.

phosphorus combined with sand or powdered glass is placed on the box to give it a rubbing surface. This prevents the match from being lighted without the phosphorus on the box to aid it in its ignition.

How to make a fire. — The following simple experiment



How air circulates in the common oil lamp.

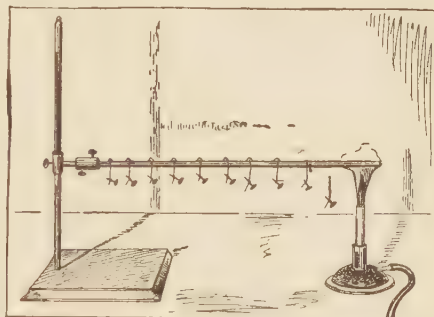
will show one factor necessary to start a fire. Cover a burning candle with a lamp chimney so that it is closed at the bottom but open at the top. The candle gradually goes out. Now cover the lamp chimney with a piece of cardboard and bring it over the lighted candle again, but leave an open space under the chimney. Again the candle goes out. Light the candle and place the chimney, open at both top and bottom, over it. This time the candle burns. Evidently a current of air is necessary to make the candle burn. Air currents

which are in circulation after a fire starts are known as *convection currents*, and as we shall see in a moment, are important factors in heating our homes. In order to start a fire in the kitchen stove or open fireplace, we put in a piece of paper and cover it with some shavings or fine kindlings, and a few small sticks on top in such a way that air can circulate around the fuel. Light the paper at the bottom, have all drafts open, and the fire burns; shut

off the air supply and it goes out. We say that hot air rises. As a matter of fact, warm air is lighter than cold air and the cold air is pulled downward with such force by gravity that the warm air is crowded out of the way. Thus smoke made up largely of hot gases is pushed up the chimney.

Demonstration Experiment. — To See if Heat Will Travel Along a Metal Rod.

Materials: A metal rod 15 to 20 inches long. Ring stand and clamp. Burner. Wax. Thread.



Method: Tie a short thread to each of six tacks. Attach these two inches apart to the metal rod by means of melted wax. Support the metal rod so that one end is in the flame of the Bunsen burner.

Observation: Notice the order of the melting of the wax and dropping of the tacks. What does this suggest?

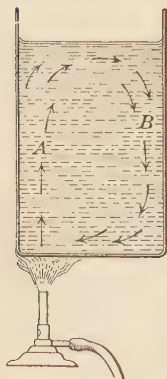
Conclusion: This process of carrying heat is called *conduction*. What does this experiment teach about conduction of heat?

Application: Explain how the conduction of heat is involved in the following cases.

1. A stove for heating a room.
2. Heating a flatiron.
3. Why the metal handle of a sauce pan gets hot.

Three methods of distributing heat. — As heated currents of air are carried up by *convection*, heat is moved about in the room and warms the cooler bodies with which it comes in contact. Thus to a great extent the rooms of our houses are warmed. Heat also moves through space where there is no air. We all know that the sun keeps us warm, but do we all know that its heat travels through vast areas of space in which no air exists? This space is

filled with ether, and through this ether heat moves by means of waves. This method of heat transference is called *radiation*. Some surfaces absorb heat much more rapidly than others. Scientists know that black or dull substances do this much better than light or shiny substances, and that substances which readily absorb heat give it up easily by radiation.



Convection currents
in a vessel of water.

A third method of heat transference is the passing of heat from one particle of material to another. This is called *conduction*. The interesting experiment described above illustrates this method of heat transference. The heat received by one set of particles is passed on to others, and by them to still others. Most metals are very good conductors. Some substances, like glass, water, and many rocks, are fair conductors, while air, wood, paper, and linen, silk, and woolen fabrics are poor conductors. This principle of non-conduction is used in making the fireless cooker, and the ice chest, where the heat is kept inside in one case, and outside in the other. Solids are the best and gases the poorest conductors of heat, air being one of the best heat-insulating (non-conducting) materials. Convection can take place only in liquids and gases. Remember that all these methods are at work in heating our homes.

How the body loses heat. — Heat is lost from the body by the three methods just mentioned. A certain amount of heat is lost by conduction, although the air is a very poor conductor, and warm fabrics get much of their heat-holding qualities because of their meshes which confine

stagnant air. Most of the heat from the body is lost by convection. When we fan ourselves, we create a current of air, causing cooler air to replace the warm air about the body. We also lose heat by radiation to other solid objects which are cold. It is very easy to take cold by sitting on the damp ground, or close to cold windows or walls, because in this way warmth is removed rapidly from one part of the body. Curiously enough, although we feel warm when we perspire, yet much of the heat of the body is being taken away by evaporation of the water from the body surface. On a hot day when the atmosphere about us



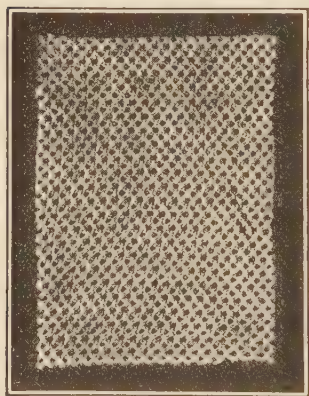
Which side of this boy will lose more heat? Why?

is moist, little heat is lost by evaporation and we feel much hotter than on an equally hot dry day when the perspiration evaporates freely. A person may feel the heat far more in New York on a day in August than in the jungles of British Guiana at the same time of year, because in the tropics the trade winds cause rapid evaporation of the moisture from the body.

Underclothes and their uses. — In winter we need underclothes which are non-conductors of heat, and retain the warmth in the body. Underclothes that do not hold moisture are desirable, for wet, clammy underclothes cool us by conduction if it is cold, or if it is warm, they make us uncomfortably hot by preventing evaporation, and some-

times even cause a cold to develop. It does not seem to make very much difference what kind of materials are used, whether woolen, cotton, linen, or silk fiber, so long as the underclothes are porous. Woolen underclothes are best for wear in winter, because their natural curly fiber makes them porous, and also because they absorb water, and this protects the skin against cooling too rapidly in case of overheating. Many colds are caused because people insist on wearing too much clothing in winter. They wear heavy underclothes and heavy outer clothes, go from a warm room to the cold outdoors, and back again to warm workrooms where the temperature is often higher than that of summer heat. The

better rule is to wear medium weight underwear in winter and heavy outside garments, which can be changed as one goes into different temperatures.



Mesh in underwear.

How to wear clothing.—The chief use for clothing is to keep heat in the body, although some people think, as in the case of some animals which wear their fur and

feathers for attraction, that "fine feathers make fine birds." Heat does not escape easily through dry air, and clothing prevents its escape by holding air in little pores of the cloth. Fur of animals, a natural covering, is very warm, yet averages in the case of many animals about 98 per cent air and only two per cent hair. The outer clothes, both of boys and girls, should not be tight fitting, and not

too heavy, especially if thick underclothing is worn. Tight-fitting clothes interfere with the circulation of the blood and are not hygienic. Clothing should therefore be loose and the weight distributed as nearly equal as possible on all parts of the body. Get the habit of wearing an overcoat, and take it off when you go into the house. Learn to wear different weights of clothes according to the temperature, keeping lightweight and more porous ones for the hot weather.

REFERENCE BOOKS

- Allen, *Sweden and Safety Matches*. Ginn and Company.
 Ashmead, *The Man Who Mines our Coal*. Scientific American, May 18, 1918.
 Barber, *First Course in General Science*, Chapter I. Henry Holt and Company.
 Bassett, *The Story of Wool*. Penn Publishing Company.
 Brownell, *General Science*, Chapter IX. P. Blakiston's Son and Company.
 Carpenter, *How the World is Clothed*. American Book Company.
 Clark, *An Introduction to Science*, Chapters I, II, IV, XI, XIV. American Book Company.
 Cleland, *Geology, Physical and Historical*, Chapter XVI (For teachers). American Book Company.
 Fall, *Science for Beginners*, Chapters XI, XXV. World Book Company.
 Faraday, *Chemical History of a Candle*. Harper Brothers.
 Forman, *Stories of Useful Inventions*. The Century Company.
 ——— *The Efficient Use of Coal*. Century, February, 1918.
 Greene, *Coal and the Coal Mines*. Houghton Mifflin Company.
 Hodgdon, *Elementary General Science*. Hinds, Hayden and Eldredge.
 Hunter, *A Civic Biology*, Chapters X, XV. American Book Company.
 Lynde, *Physics of the Household*, Chapters VIII, IX, X. The Macmillan Company.
 Maron, *The Origin of Inventions* (Fire making). Charles Scribners' Sons.
 Mumper, *Text-Book in Physics*. American Book Company.
 Routledge, *Discoveries and Inventions of the Nineteenth Century*, pages 646-652. Routledge.
 Stone, *Making a Match*. General Science Quarterly, Salem, Mass., January, 1919.
 Tappan, *Makers of Many Things* (Matches). Houghton Mifflin Company.
 Toothaker, *Commercial Raw Materials* (Coal and Oil). Ginn and Company.
 Turner, *The Study of Fabrics*. Appleton and Company.
 Weed, *Chemistry in the Home*. American Book Company.
 Whitman, *How to Make a Thermometer*. General Science Quarterly, May, 1920.

CHAPTER IX

HEATING OUR HOMES

Problems. — 1. *To see how our homes are warmed.*

2. *To find out how heating devices are constructed.*

3. *To learn the best way of regulating the fire in the stove or furnace.*

4. *To see how heat is used in cooking.*

5. *To understand how the hot-water supply system is operated.*

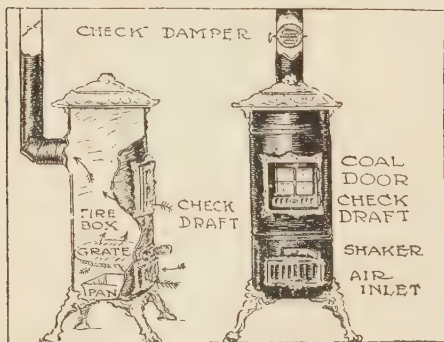
6. *To learn how to find the amount of gas consumed.*

Suggested projects. — 20. To qualify as an expert heating device operator in my home.

21. To learn how my coal range is constructed and how to run it.

How heat is used in our homes. — Without heat for warming our houses and cooking our foods, home would be a dreary place.

We do not always appreciate the hot, well-cooked dinner, warm rooms, and the cheerful fire-place because these things have long been commonplace. Heat has become a servant of man, and



A common type of coal stove.

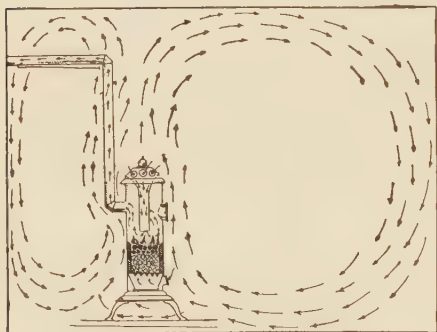
fire is harnessed in many ways that would be strange to our forefathers. As good home makers, we should

learn about the devices used for heating and cooking in the home.

The coal stove. — The ordinary coal stove used for heating or cooking is really a metal box arranged so as to admit air for combustion, and to carry the products of combustion up the chimney. The coal rests on the grate and is burned in the *fire box*. Below the grate is a compartment to hold ashes, called the *ash pan*. Each compartment has a door with openings and slides in it. The openings in the lower door form the *draft* or *air inlet*, and those in the upper door the *check draft*. In the stove pipe, which leads to the chimney, there is another device for controlling the air currents, called the *check damper*.

Regulation of fire. — In starting the fire, the lower draft and the damper should be open, but the check draft should be closed. This allows the poisonous carbon monoxide which comes from coal, to escape up the chimney. The hottest fire is obtained when the damper and draft are both open and the check draft closed, as this allows a free passage of air through the burning coal. By opening the check draft, closing the draft, and partially closing the damper, the fire will burn slowly. By closing the damper completely, the air current is checked and burning almost stops. If the room is overheated, close the draft, open the damper and one of the covers of the stove. The air from the room will then rush in over the coal and pass up the chimney, thus cooling the stove without helping the materials to burn. In checking the fire, always close the draft. If the draft is left open and the damper closed, the poisonous gas, carbon monoxide, may escape into the room. A very small percentage of this gas in the air is fatal.

How a room is warmed. — In the case of the old-fashioned fireplace, little heat is given to distant parts of the room, most of it going up the chimney. The stove transfers to the room by convection and radiation about seventy to eighty per cent of the heat obtained from the fuel. Air coming in contact with the hot surface of the



Convection currents caused by a hot stove.

stove expands, becomes lighter, and is pushed up by heavier air, which comes in to take its place (see arrows in diagram). These warm currents of air are cooled as they pass by the windows, cold walls and other surfaces which ab-

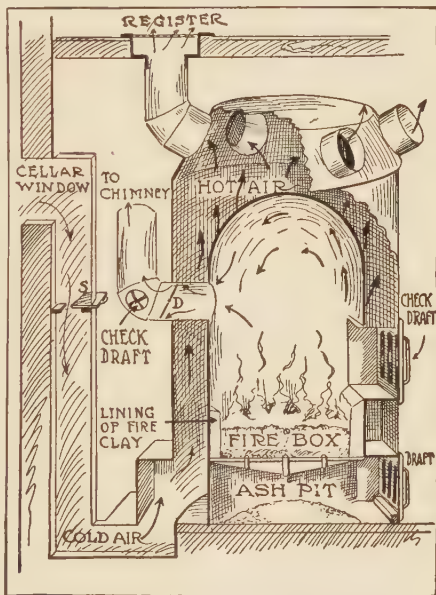
sorb heat, and sink again to the floor. Since the stove is warmer than other objects in the room, it radiates heat to them; heat is brought also through the metal from the inside to the outside surface by conduction. Thus all three methods of heat transference are used to some extent in heating a room.

The hot-air furnace. — The hot-air furnace has come into general use and is much liked because it does the work of several stoves and requires no more attention than one. The furnace is simply a large central stove placed in the cellar, and covered with a metal jacket, from the top of which metal tubes, or ducts, lead out to the different rooms to be heated. Air from out of doors is brought to the bottom of the space between the fire box and the in-

closing jacket, and as it becomes hot, rises and passes through the pipes to the various rooms. This cold air supply should be reduced in very cold weather because air at a low temperature fills more space than the same amount at a higher temperature. Houses which have a heating system in which the air after circulating in the rooms is sent back to the furnace to be heated again, use less fuel but do not have as good ventilation as those which take a fresh supply of air from the outside and heat it.

Advantages and disadvantages of the hot-air furnace.

The hot-air furnace is less expensive to install than either steam or hot water, is easily operated, gives up heat quickly, and aids ventilation by bringing a new supply of air into the room. However, it heats irregularly and is unsatisfactory on days when there is a strong wind which interferes with the air current. As a rule it uses more coal than other heaters, in proportion to the heat obtained. After the furnace becomes old, it gives off much dust and some gas into the house.



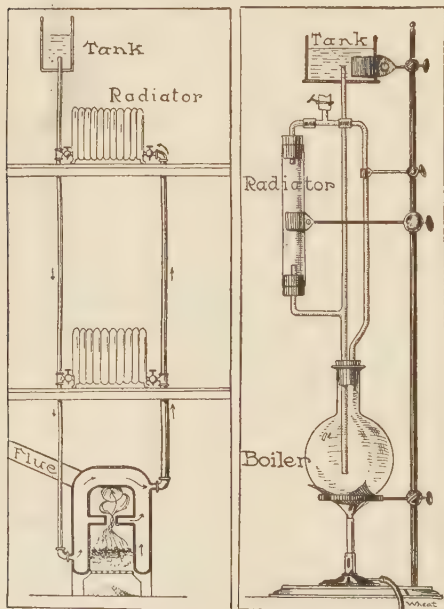
A hot-air furnace.

Demonstration Experiment. — To show the principle of hot-water heating.

Materials: Apparatus shown in diagram.

Method: Fill the apparatus with water. This can be done by pouring water into the tank at the top and opening the clamp on the rubber tube at the top of the bent tube until water fills both tubes. Drop two or three crystals of potassium permanganate through the rubber tube into the glass tube. Close the clamp and fill the tank partly full of water. Heat the flask.

Observation and Explanation: Notice all changes. Describe everything that happens. Explain what parts of a hot-water heating system are represented by the different parts of the apparatus.



Hot-water heating system at the left, and apparatus to illustrate it at the right.

The hot-water heating system. — In the hot-water heating system, we have a combined furnace and boiler in the cellar, radiators in the rooms, connecting pipes to bring the water to the radiators and back to the boiler, and a tank known as the *expansion tank* at the top of the house, in which the water may rise as it expands. The principle of heat transfer from the

boilers to the radiators is that of convection. Water leaves the boiler at a temperature of 175 to 185 degrees Fahren-

heit, and returns to it ten degrees cooler. This cooling causes the water to grow heavier, and is responsible for the flow through the pipes.

How a room is warmed by hot water. — As soon as the hot water reaches the radiator, heat is conducted through the metal to the outside surfaces. Air coming in contact with the radiators is heated, and then gives off this heat to the other objects in the room by convection, while some heat is radiated directly to the walls and objects in the room. Thus the room is heated by convection more than by radiation, and we have a more even distribution of heat than by stove or by steam.

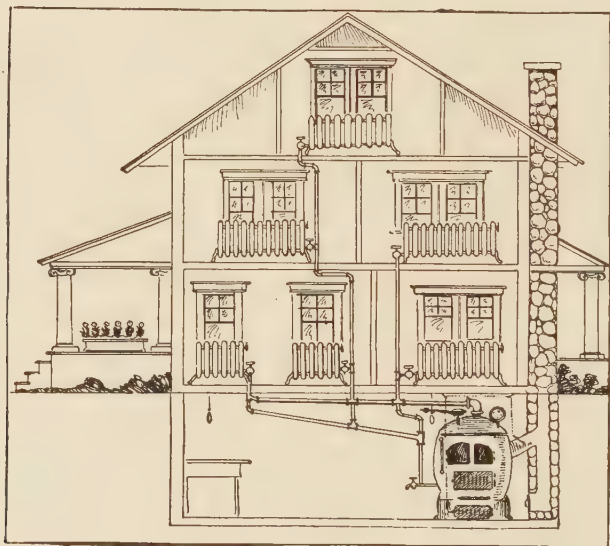
Advantages and disadvantages of hot water. — This is one of the most expensive systems to install, but it is more economical to operate than the hot-air furnace or the stove. With it the rooms may be kept at an even temperature, but unfortunately, if the water gets cold it takes a long time to warm it up. As the system provides no ventilation, we must secure fresh air in some other way. An excellent system is the combination of hot water and hot air, in which the boiler is situated in the top of the furnace, and the heated water is passed to rooms far distant from the furnace, while the hot air warms the rooms which are nearer the furnace.

Steam heat in the home. — In the steam-heating systems, the parts are practically the same as in the hot-water system, except that there is no expansion tank and the pipes are closed throughout. Steam made by boiling water passes through the pipes to the radiators where the steam condenses, giving off its load of heat. The water formed by this condensation leaves the radiator and is brought back to the furnace again, either by a system of return

pipes, or if the house is small, it may go back through the steam pipe.

Experiment. — To show the great amount of heat stored in steam.

Advantages and disadvantages of steam heating. — Although less coal is used in steam heating than in most



Steam heating system.

other systems, no ventilation is supplied and an uneven temperature is produced, the room sometimes being very hot and sometimes very cold. When steam in this system suddenly comes in contact with a cold radiator, it condenses, and a vacuum is produced. If there is water in the pipes with pressure behind it, caused by steam coming from the boiler, it may be sent through this vacuum with great speed, and made to strike a hard blow against the

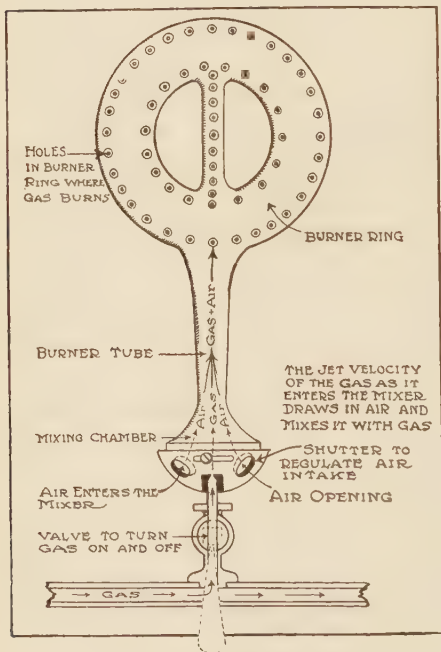
metal pipes, making a disagreeable snapping and pounding in the pipes. The remedy is to admit steam slowly when first warming up the pipes and radiators. Steam, like hot water, has an advantage over the hot-air system in that it carries no dust. Because of the high temperature of the steam radiators, they need to be only about two thirds of the size of hot water radiators. Steam is used with good results in warming large buildings.

The use of heat in cooking. — In the coal range we have the same principle of air circulation as in the coal stove. On one side of the fire box there is an oven separated from the outside walls of the stove by a space. Heat is circulated through this space to warm the oven. We can control the oven temperature by regulating the size of the fire, by the use of the oven damper, and by opening the oven door. The main air supply enters through a draft into the ash pit under the coal, passes through the layer of hot coal, helps it to burn, and the hot gases coming from the burning coal pass around the oven and escape up the stove pipe. The oven damper, if raised, causes these gases to pass around the oven before entering the stove pipe. When the oven damper is down, the hot gases pass directly out. What would you do to cool the oven?

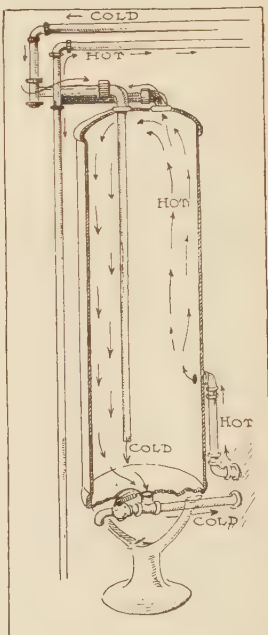
Experiment. — How to produce a luminous and a non-luminous gas flame.

The gas range. — In many homes where gas is available, the gas range has supplanted the coal or wood range for cooking. It is not only quicker, cleaner, and more convenient, but, if natural gas is available, it is much cheaper. Each top burner has a mixing chamber, in which are openings for the entrance of air. The air mixes with gas entering the tube, and the mixed gases are passed out

through small holes in the burner ring, and burned. This burning should take place with a blue flame. If too little air is admitted, the flame will be yellow, and soot will collect on the cooking utensils. The burner should be kept clean, for dirt clogging the air inlets will cause smoke.



Top burner of the gas range.



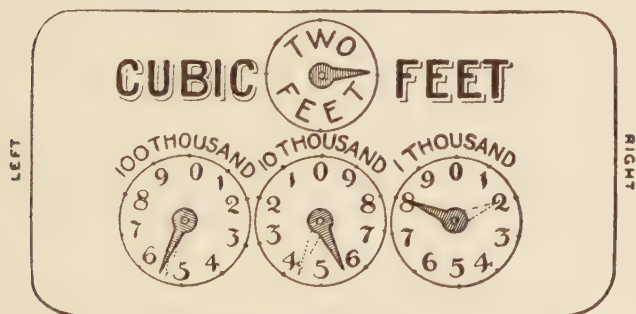
Hot-water supply.

The hot-water supply.—The hot-water supply for household purposes is obtained by the use of a hot-water storage tank connected to the coal range or independent heater. In the range the water is heated by means of a pipe passing close to the fire box, and then running to the boiler. In the gas hot-water heater the gas flame heats a

coil containing cold water, the rapidly heated water rises as it becomes lighter, and passes into the pipe of the hot-water tank. When the hot water is drawn from the faucet, a supply of cold water enters through the pipe which enters at the top of the tank and extends down to a level just above the top of the heating device.

Experiment. — How to read gas meters.

Reading the gas meter. — Since gas is a commodity which is delivered to our homes, we should learn to read



Recording dials of gas meter.

the meters, so as to be able to know how much gas is burned, and whether we use it economically. The recording device of a small gas meter has three small dials, and a fourth one still smaller on top, which has a scale registering two cubic feet. Above the three dials are marked the figures 100,000, 10,000, and 1,000, and the face of each dial is figured from 0 to 9. When the gas passes through the meter, the hands revolve, the two outer ones in the direction of the hands of a clock, and the middle one in the opposite direction. In the illustration the 100,000 dial hand is between 5 and 6, the 10,000 between 5 and 6, and

the 1,000 at 8. This means that the meter stands at 55800 cubic feet. The last time the meter was read, as the dotted position of the hands shows, it stood at 54200. Another kind of meter is so arranged that a certain amount of gas is given out after placing a coin in a slot in the meter. When this gas is exhausted, the meter automatically cuts off the supply until another coin is dropped in. One may easily check up the amount of gas which can be used before the supply is cut off by reading the special index controlled by the coins inserted.

Other fuels and fuel using devices. — Many people who have no gas piped into the houses, use the blue flame kerosene ranges. In these ranges the fuel flows from a reservoir down to a wick in the burner, where, as the metal becomes heated, the fuel evaporates, mixes with air and burns in the same manner as does the gas in the gas stove. In practically all ranges using kerosene the blue flame is produced in this way. The common kerosene heater is like the central draft lamp and gives a yellow flame. Alcohol is sometimes used as a fuel where a hot flame is needed for a short time, and many of us have used "solidified alcohol" which now comes in convenient tins. In this form of fuel the alcohol is absorbed in a soft wax or paraffin. It must be kept from the air, however, or it will lose the burning properties quickly through evaporation. Alcohol lamps in which vaporized alcohol is burned to heat a mantle to incandescence give a brilliant white light. Small alcohol torches for soldering are useful in the home. The blast torch has a compressed air chamber above the liquid. This air pressure forces a fine spray of fuel into a heated tube where it burns like a gas blast flame.

SCORE CARD

147

SCORE CARD. HEAT IN MY HOME

	EXCELLENT	FAIR	VERY POOR	My Score	
					Total
WARMTH	All parts of home warm enough in coldest weather (5) All parts of each room can be evenly heated (5)	Some rooms not warm enough in coldest weather (4) Some rooms evenly heated; others not (3)	Temperature in all rooms too cold in coldest weather (0) Unequal heating in all rooms (0)	....	....
VENTILATION AND PROTECTION AGAINST LOSS OF HEAT	Large supply of fresh air circulated in rooms (2) All pipes and furnace protected against loss of heat (2) Weather strips, storm doors, and storm windows new and tight, ventilation sashes in windows (6)	Small supply of air circulated in rooms (1) Pipes but not furnace protected against heat loss (1) Weather strips old, storm doors leaky, storm windows without ventilationsashes (3)	No air in heating circulation (0) No protection of pipes or furnace (0) No weather strips, storm doors, or sashes. Windows rattle in wind and allow air to enter (0)	....	....
ECONOMY OF FUEL	Fuels (except gas) purchased in large quantities at one time (4) Wood, coal, coke, or natural gas used in kitchen in winter (2) Fuel not wasted in ashes or more gas burned than needed (2) Electric heat seldom used (2)	Fuels purchased in small quantities as: 1 gal. oil; 1 ton coal (2) Artificial gas used sometimes when have coal or wood fire (1) Fuel often saved by attention to gas burner and ash sifting (1) Electric heat often used (1)	Very small quantities purchased as: 1 qt. oil; 1 bag coal (0) No saving attempted by using cheaper fuels (0) No attention paid to economical use of gas or to ashes (0) Electric heat commonly used (0)	....	....
ECONOMY IN TIME AND WORK DONE	No extra dust in winter (3) No ashes (electricity or gas) (3) Not more than 15 min. per day for proper care of heating devices (2) Thermostats and other heat regulating apparatus (2)	Little extra dust in winter (1) Little ash or clinker (2) Not more than 30 min. required for care of heating devices (1) Lacks either thermostats or heat regulating apparatus (1)	Much extra dust in winter (0) Much ash or clinker (0) More than 30 min. a day required for care of heating devices (0) No thermostats or heat regulating apparatus (0)	....	....
COOKING	Cooking stove makes no dust or dirt (electricity) (2) Stove safe (2) Stove easy to manage (3) Cooks and bakes well (3)	Cooking stove makes little dust or dirt (gas, kerosene) (1) Stove less safe (1) Stove less easy to manage (2) Cooks well; bakes poorly (1)	Cooking stove makes much dust or dirt (wood, coal) (1) Stove not safe (0) Stove difficult to manage (0) Cooks and bakes poorly (0)	....	....
GRAND TOTAL			PERFECT SCORE 50		

REFERENCE BOOKS

- Barber, *General Science*, Chapter II. Henry Holt and Company.
- Burns, *Story of Great Inventions*. Harper and Brothers.
- Butler, *Household Physics*, Chapters on Heat, pages 6-57. Whitcomb and Barrows.
- Caldwell and Eikenberry, *General Science*. Ginn and Company.
- Clark, *An Introduction to Science*, Chapters I, II, III. American Book Company.
- Hopkins, *Experimental Science* (For help in projects). Munn and Company.
- Lunt, *An Illuminating Gas Project*. General Science Quarterly, May, 1917.
- Lynde, *Physics of the Household*, Chapters VII, XI. The Macmillan Company.
- Mowry, *American Inventions and Inventors*. Silver, Burdett and Company.
- Smith and Jewett, *Introduction to the Study of Science*, Chapter II. The Macmillan Company.
- Walrath, *Hot Water Boiler Demonstration*. General Science Quarterly, Jan., 1918.
- Williams, *How it Works*, pages 386-391. Nelson Company.
- Williams, *Introductory Fire Lesson*. General Science Quarterly, May, 1917.

CHAPTER X

FIRE PREVENTION IN THE HOME

Problems. — 1. *To learn the estimated fire loss in the United States.*

2. *To discover the usual sources of fires.*

3. *To understand why "fire prevention" is so important.*

4. *To learn the principles underlying the putting out of fires.*

5. *To see how home fire extinguishers are constructed and used.*

Suggested project. — 22. *To remove the fire hazards from my home.*

Fire and its dangers. — You may have been fortunate enough never to have lost your home or loved ones through fire, but nevertheless that danger is always near you. It stands ready for the careless moment when you give it an opportunity to burst forth with its suffocating and deadly flames, and many are its victims. Every week the papers have accounts of destruction and suffering caused by fire. If reports of the fires which have occurred in the entire United States in the last twenty-four hours could be laid on your desk you would have a collection of about fifteen hundred. Records of past years show that the number of fires averages about fifteen hundred a day; one every minute.

Enormous fire losses. — The fire loss in the United States for 1919 was \$325,000,000. There were in the United States during 1919 over 5,000,000 fires. Suppose these fires spread at equal intervals of time, and the fire loss was distributed evenly throughout the year, then,



Modern fire apparatus in action.

every second \$10.00 in property is destroyed; every minute a new fire starts somewhere in the United States; every hour two lives are lost and seven persons are injured through fire; every day enough property value is destroyed by fire to feed and clothe a city of 50,000 people for ten days; every week the fire loss is enough to build 100 miles of good macadam road; every month the loss from fire is equivalent to a sum of money which would

buy the grounds, erect the buildings, and provide an endowment to pay the running expenses of a large college. In a year, the money value of fire losses would pay salaries, books, and supplies for all public education in the entire United States for more than half a year.

Charles W. Baker, in an address entitled "A Street of Desolation," said in speaking of the damage done in a

single year that "the buildings consumed, if placed on lots of 65 feet frontage, would line both sides of a street extending from New York to Chicago. A person journeying along this street of desolation would pass in every thousand feet a ruin from which an injured person was taken. At every three quarters of a mile in this journey he would encounter the charred remains of a human being who had been burned to death."

Why are there so many fires? — Are these losses by



Relative per capita fire losses in different countries.

fire necessary? What causes the fires? Many fires are reported as "cause unknown," but a study of the causes in a large number of other cases shows that the principal cause of fires is CARELESSNESS. Many a thoughtless smoker has destroyed lives and valuable property by throwing away a lighted match or burning cigarette which has blazed up later — and may have been unnoticed until it had a big start. No one of us can truthfully say that he has not been careless about such matters. It is time that we begin a new era of thoughtful, careful attention to the

ways and means of safeguarding the home, the business houses, and the factories against fire.

Sources of fires in the home. — The cause of about 90% of the fires is carelessness in regard to a few things about the home. Some of the most important things about which we ought to be more careful are:

- a.* The use of kerosene and gasoline.
- b.* Matches and all uncovered flames.
- c.* The heating plant, stove pipes, and chimney.
- d.* Electrical devices and wiring.
- e.* Oily rags and other rubbish.



Which lamp is the greater fire hazard?

Matches. — In the United States half a million flames are produced with matches on an average every minute. Every bare flame has the possibilities of serious consequences. Our chief concern in the house as regards matches is to keep them away from children who are too young to realize the danger, and from rats and mice, which are known to cause fires by gnawing the match

heads. Heated pipes or flues ignite matches. Some of these dangers may be avoided by keeping matches in covered metal boxes out of reach of small children.

Flames for light. — The candle, kerosene lamp, and gas flame are common sources of danger in the home. Many a fire has started from a curtain or drapery blowing into a flame and blazing up rapidly. Look out for this and do not go off and leave a burning lamp or gas flame unwatched for a long time. Candle shades made of paper or cloth get on fire easily if not protected by a mica chimney which separates them from the flame. A serious fire would be likely to result from tipping over a lamp as the kerosene would run out and drench everything near and the blaze would be difficult to extinguish. To avoid such danger use lamps and candlesticks which have a low center of gravity and stand solidly in a broad base. How terrible to drop a lighted lamp! One's clothing might get on fire, and a big blaze would follow.

Filling a lamp which is burning may cause the flame to jump back and set the kerosene on fire. To prevent some of these dangers use lamps with a metal reservoir, which are kept clean and filled by daylight.

Fire dangers from heating devices. — Disastrous fires from chimneys, stoves, furnaces, and portable heaters are common. Perhaps most deaths from burning are the result of carelessness when kindling a fire in the stove.



She had used kerosene oil to start her fire 432 times without harm. The picture shows what happened on the 433d time.

Scarcely a week goes by but you may find in the papers an account that some one who used kerosene to kindle the fire was seriously, if not fatally, burned. Hot stove-pipes, the heater, or hot-air ducts, if close to woodwork, are fire hazards because they may cause a slow smouldering fire which will spring into a blaze when reached by a draft of fresh air. Ashes are never safe when left loose on the cellar floor, or in wooden receptacles. Metal containers are the only safe ones.

Miscellaneous sources of fire. — All celluloid articles contain the oxygen necessary for combustion within themselves. On this account celluloid burns quickly and cannot be extinguished by smothering. Hot air from a register will sometimes ignite celluloid. Make a list of celluloid articles in your home.

Spontaneous combustion is a frequent cause of disastrous fires. Certain oils, as linseed oil used by painters, absorb oxygen in drying and generate heat by this process. If the oil is on poor heat-conducting materials, as rags and cotton waste, the heat may increase enough to reach the kindling point of the materials and fire results. This usually happens when nobody is around and the fire makes good headway before it is discovered.

Demonstration Experiment. — To show how spontaneous combustion takes place.

Materials: Carbon disulphide. Phosphorus. Test tubes. Filter paper. Ring stand.

Method: Dissolve a piece of phosphorus the size of a pea in half a test tube of carbon disulphide.

(*Note:* Do not handle phosphorus with bare fingers. Phosphorus and carbon disulphide are both inflammable.) Wet the filter paper with this solution by rolling it up and inserting it into the test tube. Open the paper and expose it to the air on a ring stand. As the carbon disulphide evaporates the phosphorus oxidizes and generates heat.

Observation: Tell what happens.

Conclusion: Was heat generated faster than it could be carried off? Explain just how the fire occurred.

Application: Linseed oil, used in paints, oxidizes rapidly in air. Under what conditions might this be a dangerous source of fire?

Burning fats or oils used for frying on the stove are not serious dangers as they can be smothered easily with a cover or a heavy rug. Do not try to carry the burning fat to the sink as the addition of water will scatter flaming droplets of fat and spread the fire.

Gasoline is treacherous. — Gasoline is a good cleaning fluid because it dissolves grease — but it is not safe to keep it in a glass bottle and must not be used near a stove nor light lest it get on fire. There are other liquids easily obtainable which will not burn, but which will clean just as well as gasoline. These can be bought at the drug store. They are safe. Use them.

Extinguishing fires. — Since a fire requires oxygen, fuel, and a temperature above the kindling point, if you deprive a fire of any one of these three, it will be extinguished. There are, then, three possible ways to put out a fire: by smothering, by removing the fuel, and by cooling.

Smothering. — Smothering is the process of keeping oxygen in the air away from the burning substance and is usually an effective way of extinguishing a small fire. A woolen blanket, wet, if possible, a rug, or coat may be used for this purpose. Another way to smother a flame is by setting free a non-combustible gas about the flame which will push the air away and extinguish the fire. This is sometimes done with the following chemicals: carbon dioxide, ammonia, carbon tetrachloride, and water in the form of steam. Substances like celluloid, and ex-

plosives which contain sufficient oxygen for combustion, cannot be extinguished in this way.

Removing fuel. — It is often possible to remove the combustible material from the vicinity of the flame and thus extinguish it in a short time. Covering combustible material by banking with sand and trenching to remove



Water, our best fire extinguisher.

fuel are practiced in brush and grass fires. Back firing in forest fires utilizes the principle of fuel removal, as does the dynamiting of buildings in the path of the fire in a large city conflagration.

Cooling. — Water is the most universal fire extinguisher as it has many properties which favor its use. It is non-combustible and can be thrown long distances in a steady stream. It has greater cooling effect than the same weight of any other substance. On changing from

liquid to steam it increases in volume 1700 times and in the process absorbs a large amount of heat, thus adding to its value as a cooling agent. The steam also tends to smother the fire by excluding air.

Demonstration Experiment. — How to extinguish burning liquids.

Materials: Lard. Gasoline. Evaporating dish. Ring stand. Heavy cloth. Carbon tetrachloride. Test tubes.

Method: (a) Heat a teaspoonful of lard in an evaporating dish. Set it on fire. Pour two or three drops of water from the test tube into it. Smother with a wet cloth. (b) Pour a tablespoonful of gasoline into the small evaporating dish. Set it on fire. Pour carbon tetrachloride into it from a test tube. (Note: Carbon tetrachloride is non-inflammable and evaporates as easily as gasoline.)

Observations: (a) What happened when water was dropped into hot fat? Result with the wet cloth? (b) Does water extinguish burning gasoline readily? Does carbon tetrachloride?

Conclusions: What is your conclusion regarding proper methods of extinguishing (a) burning fats? (b) burning gasoline?

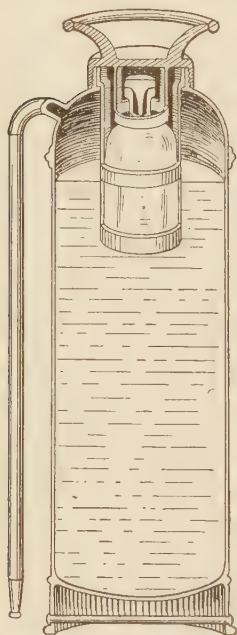
Applications: Suppose a kettle of hot lard catches fire on the stove, would it be a good plan to carry it to the sink and run water into it? Explain. 2. What commercial fire extinguishers are good to keep in the garage and in the automobile with which to fight a gasoline fire?

The hand chemical extinguishers. — The carbon tetrachloride and the carbon dioxide extinguishers are two types of chemical extinguishers suitable for use in the house, the school, and the shop when the fire is small.

The carbon tetrachloride extinguisher is a small container to which a force pump is attached. When the container is opened and the pump worked, a stream of liquid is thrown upon a near-by blaze where it is changed to a gas which smothers the flame. Whenever this extinguisher is used take care not to breathe the fumes given off by it for they are harmful and in a number of instances have proved fatal. This type of extinguisher is particularly valuable for putting out small gasoline and oil fires

where water cannot be used since the oil or gasoline rises to the surface of the water and continues to burn.

The small carbon dioxide extinguisher holds $2\frac{1}{2}$ gallons of water, in which are dissolved $1\frac{1}{2}$ pounds of baking soda, and a bottle containing 4 oz. of strong sulphuric acid is



Section of a carbon dioxide extinguisher.

suspended above the solution. When the extinguisher is inverted, the acid mixes with the soda and produces carbon dioxide gas. This gas is confined and creates such great pressure that the liquid is forced out through the hose to a distance of 40 to 50 feet. The water which escapes is charged with carbon dioxide and has some soda in it, all good fire extinguishers. The flow of liquid may be stopped at any instant by inverting the extinguisher again. But after once inverting, the extinguisher may not be used again until it has been recharged. This is the kind of extinguisher for the house, since there is less suffocating gas than in the case of the tetrachloride gas extinguisher, which should be used in the garage.

Make Christmas fireproof. — The Christmas cheer in some homes is changed to grief because of a tragedy brought by fire. In order to feast the eye on a thing of beauty, the Christmas tree is decorated with flimsy and highly inflammable paper and cotton to represent snow. The packages and toys are inflammable as is also the tree itself.

Illumination with burning candles is inexcusable. When electric lights are used, great care must be observed to see that there are no defects in the wire insulation. A short circuit in the wiring system can easily start a serious fire. Metal tinsel and other noninflammable decorations, with flake asbestos for snow, make an attractive looking tree. Never take chances with fire.

Safety first. — If you get caught in a burning building, and the fire has made such headway as to be a serious menace to you, it is your first duty to save yóur life. It is well to be prepared for any emergency and to know in advance just what to do. Do you know where the stairs are? The fire escapes? If it is necessary to pass through a smoke-filled room, tie a wet cloth over your nose and mouth to absorb the smoke and crawl on the floor as smoke rises and there is less near the floor. Bed clothing may be tied into a rope on which to descend to safety. But above all *keep cool*.

Scoring fire hazards. — Score your fire hazards rigidly, and then go over your list carefully to see what changes you can make *at once* to improve conditions. If the matter is outside your control,

talk it over with other people and get their advice as to the best way to do away with the hazard. We should all work together to prevent unnecessary fires. A rather different score card could be made by boys and girls living in small rural communities or in farming or lumbering sec-



The best air in a burning house is near the floor.

SCORE CARD. FIRE HAZARD SURVEY OF MY HOME

		SCORE		
			Perfect	Allowed
1.	Fireproof constructions Slate or other fireproof roof Stone, brick, or concrete walls	$2\frac{1}{2}$ $2\frac{1}{2}$	5	
2.	Not nearer than 25 ft. to other wooden buildings		5	
3.	Metal ash cans used Gas connections of metal pipe, not of rubber	$2\frac{1}{2}$ $2\frac{1}{2}$	5	
4.	Matches Safety matches used Out of reach of children	$2\frac{1}{2}$ $2\frac{1}{2}$	5	
5.	(a) No swinging gas jets or lamp brackets near curtains (b) Oil lamps of metal, low, not easily upset (5). Score <i>either</i> (a) or (b)		5	
6.	No one in family is careless with fire No smokers in family	$2\frac{1}{2}$ $2\frac{1}{2}$	5	
7.	No stove pipe through wall or floor No stove within one foot of unprotected wall Metal or asbestos mat under stove and extending 10 in. in front	2 $1\frac{1}{2}$ $1\frac{1}{2}$	5	
8.	No gasoline kept in glass bottle No gasoline used for cleaning indoors Kerosene never used in kindling fire	$1\frac{1}{2}$ $1\frac{1}{2}$ 2	5	
9.	No rubbish allowed to collect No oily rags collect or left No celluloid articles in house	2 $1\frac{1}{2}$ $1\frac{1}{2}$	5	
10.	Have a hand fire extinguisher Fire engine house within $\frac{1}{4}$ mile Hydrant within 300 ft. of house Fire alarm box within 500 ft. or have a telephone	2 2 $\frac{1}{2}$ $\frac{1}{2}$	5	
	TOTAL		50	

tions. If you live under such conditions, try to make a score card to fit your conditions.

REFERENCE BOOKS

Adams, *Harper's Outdoor Book*, pages 191-200 (Fire engines). Harper and Brothers.
Circular 75. Safety for the Household, U. S. Bureau of Standards: good account of fire hazards and treatment of injured.

Crocker, *Fighting Fire*. Dodd, Mead and Company.

Hill, *Fighting a Fire*. The Century Company.

Moffet, *Careers of Danger and Daring*, pages 209-256 (Life of firemen). The Century Company.

Report U. S. G. S. for 1909: data and comparisons on the amount of fire damage done in the U. S.

Reports from State Fire Marshal: in most states.

Richman and Wallach, *Good Citizenship*. American Book Company.

Safeguarding the Home against Fire: A pamphlet, 91 pp. By National Board of Fire Underwriters: very complete account of causes of fires, how to guard against them, and what to do in emergencies.

Warren, *Stories from English History*, pages 303-307 (Great fires). D. C. Heath and Company.

Weeks, *Avoidance of fires*. D. C. Heath and Company.

Whitman, *Fire Hazards and Safeguards: Ten Lessons*. General Science Quarterly. March, 1920.

PART IV. LIGHT IN THE HOME

CHAPTER XI

LIGHT FOR HOME USE

Problems. — *To understand the importance of light and eyes.*

2. *To see what important properties of light we utilize.*
3. *To understand how my home is lighted by natural means.*
4. *To understand how my home is lighted by artificial means.*
5. *To compare the different types of lighting.*

Suggested project. — 23. To improve the lighting of my home.

Light and mankind. — Think of the long dark winter in the Arctic and then try to imagine what a dismal place the earth would be without light! No green plants could



The sun is the source of all energy.

grow and only the lowest forms of life — if any — could exist in total darkness. We depend upon the sun and its radiant energy, which travels to us

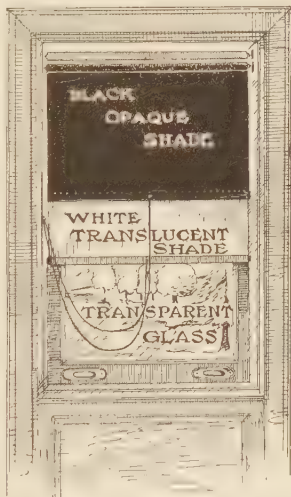
across an ether space just as heat does, and our homes have been planned so that we can make use of both natural and artificial light. Since much of our light

comes from the sky rather than directly from the sun it is very important to have a large amount of sky visible from our windows in order to get plenty of light.

How does the sky give light? — This seems a simple question, but before we can answer it satisfactorily, we must learn some very important properties of light. If we place a lighted candle or lamp on the table, of course we can all see it and even holding a piece of window glass in front of it does not in any way obstruct the light. We call an object such as the glass *transparent*. On the other hand, a piece of oiled paper or ground glass, if placed in front of the candle, allows a certain amount of light to go through, but we cannot see the flame distinctly. Such a substance is called a *translucent* body. If we hold a board or piece of sheet metal before the light, it prevents any light from reaching our eyes. Such a substance is called an

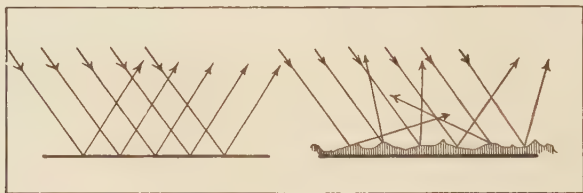
opaque body, and the space behind such a body, from which light is excluded is called a *shadow*. Light passes through transparent bodies without much loss or scattering of the rays. Less light passes through translucent bodies, scattering the rays of light, while no light at all passes through opaque bodies.

Experiment. — To classify bodies according to their ability to transmit light.



Which obstructs the most light?
Which the least?

Reflection and its reasons. — If you take a smooth surface, such as a mirror, and allow light to fall on it, a strong beam is reflected, while from a roughened or irregular surface the light is scattered, or diffused and no beam is reflected. It has long been known that light striking a flat smooth surface would be reflected from it at exactly the angle at which it strikes it. If, in a beam of sunlight the rays which travel parallel to each other



Which surface diffuses light?

strike a roughened surface, they are thrown off in different directions and produce *diffused* light.

Light from the sky. — These facts help us to understand why we get light from the sky. The air around us contains particles of solid and liquid material, as dust, and moisture. It is very seldom that the air is clean, even at points far above the earth, and in it there are always enough of these dust particles to divert the rays of light from the sun. Since the surfaces of these particles are irregular, the light is diffused in all directions. Thus it is that particles in the air above our homes, receiving sunlight, divert some of its rays to us, no matter where we may be.

Natural light in the home. — Fortunate is the boy or girl who lives in a detached house, which is bathed by direct sunlight on bright days, and is made cheerful by

having some of its beams enter the rooms. Within the crowded city with its tall buildings standing close together, with one home piled on top of another, in apartments, people rarely get direct light in more than one or two rooms, and in many city homes no direct light enters at all. A city apartment should always be chosen with



A house with plenty of light.

reference to the amount of light reaching its windows. We should always plan for sunlight in at least the living rooms. For this reason corner apartments, though more expensive, are usually more healthful. Light is of great importance to us, not only because it makes possible to see objects by the light rays which come from them, but also because it destroys bacteria and benefits health. We must remember also, if we live in the country, that too many trees shading the house are as bad as too few. Hills, buildings, porches and other overhanging parts of the house cut off light and give a dreary, unhealthful appearance.

Regulation of sunlight in the home. — It is a very good rule in planning a house to have the window space of a room from one fourth to one fifth of its floor space as this will give a sufficient amount of light for most purposes. The bedroom may have less window space, but light and



Both these rooms receive the same amount of light. One has dark wall paper and the other light.

air must not be shut out by having window hangings and draperies. If the wall paper and woodwork of a room are dark they will absorb so much light that the room itself will be dark. As a rule the ceiling should be light, the walls a little

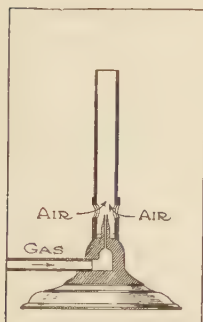
darker, and the floor still darker in order to give a good distribution of light within the room. If a room is too light, and at the same time too hot in summer, the amount of light and heat, to a certain extent, may be regulated by means of blinds or awnings. With the Venetian blind or porch shade it is possible to shut out the sun's rays without preventing a circulation of air.

Artificial light in our homes. — Up to the time of the Civil War, tallow candles, pine knots, and heavy oils such as whale oil were common sources of artificial light in the home. Petroleum was introduced for lighting purposes in 1858, and so rapidly did its use grow that in 1860 two million barrels were produced, and to-day, almost three hundred million barrels are consumed in a year. Although

artificial gas was slow in its introduction, it now plays a very important part in the lighting of our houses. About 1890, electricity came into general use for lighting purposes, and is now one of our best servants in the home. To-day people use eighteen times as much light as they did one hundred and fifty years ago, and at one third the cost.

Kerosene light. — Kerosene oil continues to be one of the common means of illumination, especially in country homes. When oil first came into use, it burned with a smoky flame, but in 1783, Argand, a Swiss physician, made a ring-shaped wick with a central draft that gave a clean, smokeless flame. This burner allowed convection currents to be set up inside the wick, and thus a larger flame could be fed with oxygen. Flat wick lamps which give smokeless flames are in common use now, but the central draft lamp gives more light.

Gas in the home. — Gas, passing from the outlet of an ordinary burner since it has not been previously mixed



A Bunsen burner.

	.05	1¢	2¢	3¢	4¢	5¢	6¢	7¢	8¢	9¢	per Hour
											Fish Tail Burner
											Inverted Mantle
											Upright mantle
											Junior upright mantle
											Burner turned down
											Mantle pilot

Effect of gas appliance on cost of gas. Black = minimum; black and white = maximum; M = mean cost per hour.

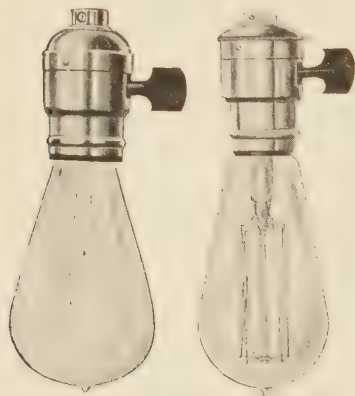
with air, burns with a yellow flame and is very wasteful. The Bunsen burner, in which air is mixed with the gas,

gives a clean hot flame which is not very luminous. A combination of this type of burner, which produces much heat, with a mantle which glows when heated, forms the Welsbach light. Welsbach mantles are made from compounds of two rare metals, thorium and cerium, which when heated to a high temperature give the bright light we are so familiar with.

Demonstration Experiment. — To show the advantage of the mantle in gas lighting.

Connect a common fishtail burner and a Thorp gauge to the gas supply. Light the burner and see how many cubic feet of gas per hour are registered. Replacing the fishtail burner by a mantle and burner, how does the light produced in the two cases compare? How much gas is being consumed in the latter case? What is your conclusion? (If a Thorp gauge is not available, test the gas consumed in a specified time by observing the small indicator of the gas meter dial.)

The first electric lamp. — The story of the invention of the incandescent light by Thomas Edison is well known.



The carbon filament incandescent lamp and the modern tungsten lamp.

He worked for a great many years and spent hundreds of thousands of dollars in the perfection of the bulb light, patented in 1880, which he furnished finally with a carbon filament, made of bamboo. Electricity is a form of energy which is conducted easily by metals and less readily by carbon. Every conducting substance, how-

ever, offers resistance to electricity. That part of the electrical energy used in overcoming this resistance is changed into heat, which when intense enough produces light.

Experiment. — To show the advantage of tungsten over carbon lamps.

Demonstration Experiment. — To see how electrical energy may be changed into light.

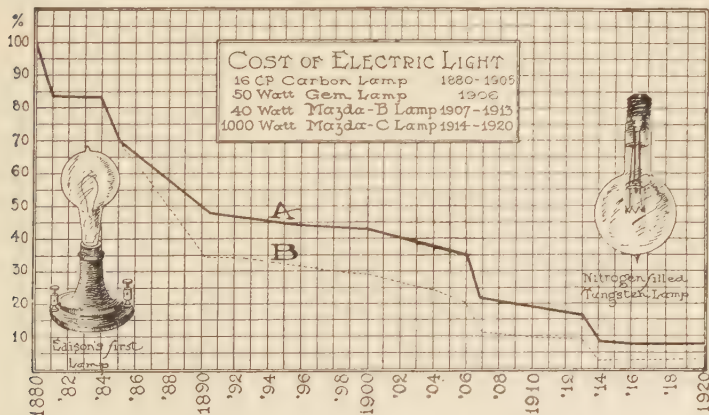
Materials: Sixteen feet No. 20 bare iron wire. Two ring stands or other supports. 110 volt electric light circuit. No. 16 insulated copper wire (Circuit must be wired and fused for twenty-five amperes).

Method: Suspend a fifteen-foot length of iron wire No. 20 from insulated supports. Fasten one wire of a 110-volt circuit to one end of the iron wire, and bring the other end of this circuit in contact with the other end of the wire. Move the free end of the circuit wire along, shortening the length of the iron wire until it becomes red hot. All this heat energy is produced at the expense of electrical energy. As the wire is shortened the heat increases. The hotter the wire, the greater percent of electrical energy is changed to heat.

Observations: Record your observations.

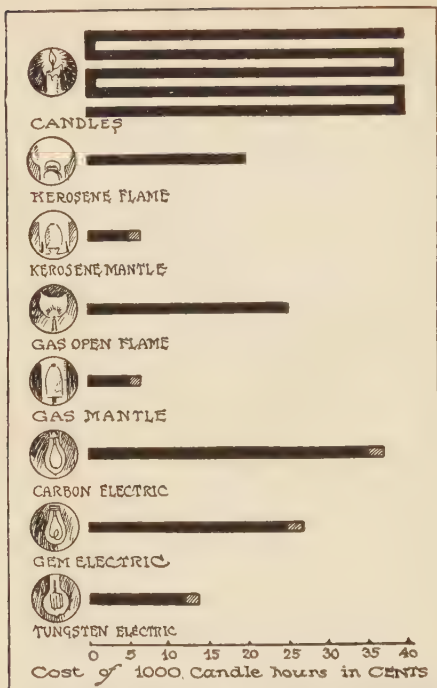
Conclusion: What is one important source of artificial light?

Application: How is this principle applied in our common electric lamps?



Graph showing decrease in cost of electric lighting in forty years. A is the reduction due to lamp improvement only; B, due to lamp improvement and reduced rates for current.

The tungsten light. — The carbon filament can be heated to 1850° Centigrade, and the tungsten filament to 2100°



This chart, suggested by the Bureau of Standards, shows the relative cost of light from different illuminants, based on the following prices: candles 12¢ a pound; kerosene, 15¢ a gallon; gas \$1 per 1000 cu. ft.; electricity, 10¢ per kilowatt-hour. Solid black represents cost of fuel, and shaded, cost of mantles and bulbs. Revise this chart in your notebook to agree with cost of these illuminants in your own city or town.

Centigrade, while in bulbs which are filled with nitrogen, the temperature may go still higher. The higher the temperature is, the greater the amount of electrical energy changed to light; therefore we get a much brighter light from the tungsten than the carbon filament. A one hundred candle power tungsten, nitrogen-filled bulb requires only about one seventh as much electricity as the one hundred candle power carbon lamp. The following table shows some

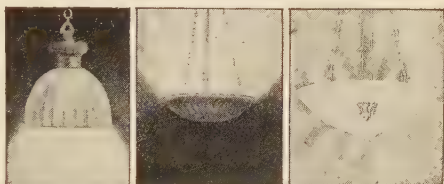
of the intensities of lights commonly used in the home.

TABLE OF INTENSITIES OF COMMON TYPES OF LIGHTING

The common carbon incandescent lamp	16 candle power
The small tungsten incandescent lamp	20 " "
The fishtail gas flame	22 " "
The Welsbach gas flame	60 " "
A 100-watt tungsten incandescent lamp	92 " "

Methods of lighting. — Several ways of lighting by electricity are now in use. In *direct lighting*, the light is thrown directly from the lamp or by a reflector to the place where it is used. This produces a glare in some directions and has a few disadvantages which we shall study in connection with the eye. Direct lighting is economical because little light is lost through diffusion or absorption.

In *indirect lighting*, an opaque reflector comes between the eye and the bulb and all light is directed upward to a white or light colored ceiling where the light is diffused, made to resemble daylight in its general effect. This is not an economical method of lighting, but it is pleasant and restful for the eyes. In *semi-in-*



Explain how these pictures illustrate *direct*, *indirect*, and *semi-indirect* lighting.

direct lighting, a translucent reflector throws most of the light to the ceiling, while some light passes through the shade. There is no glare in this system, and its cost is intermediate between the other two systems.

Use of the score card. — Here the boy and girl in the country will probably have the advantage in natural lighting, but the city child will perhaps have better conveniences in artificial light. Study carefully to find out the relative cost of your lighting system and make inquiries as to the cost of light in your town.

SCORE CARD. LIGHTING MY HOME

				MY SCORE	
					Total
SUNLIGHT	Three fourths of all rooms have direct sunlight (4)	Half the rooms have direct sunlight (2)	No rooms have direct sunlight (o)	....	
	All rooms well lighted by natural light. No artificial light needed before sundown (2)	Half the rooms well lighted by natural light; no artificial light before sundown (1)	No rooms in which artificial light is not needed before sundown (o)	...	
	Home not directly shaded (2)	House partly shaded (1)	House densely shaded (o)	....	
	Well-lighted airy cellar (2)	Cellar not light but airy (1)	Cellar dark and musty (o)	...	
WINDOWS AND WALL PAPER	Window space at least $\frac{1}{2}$ floor space (4)	Window space at least $\frac{1}{3}$ floor space (2)	Window space less than $\frac{1}{3}$ floor space (o)	...	
	Awnings or shutters provided (2)	Shutters, no awnings (1)	No shutters or awnings (o)	...	
	No dark hangings at windows (2)	Dark hangings at some windows (1)	Dark hangings at most windows (o)	...	
	No rooms having dark wall papers (2)	One half rooms having dark papers (1)	Three fourths rooms have dark wall paper (o)	...	....
COST OF LIGHTING. PROPER LIGHTING FOR ALL KINDS OF WORK	Economical (Consult tables) (10)	Moderately economical (5)	Expensive (o)	....	
	No direct light or glare in eyes (2)	Sometimes direct light in eyes (1)	Usually direct light in eyes (o)	....	
	Strong light for sewing (2)	Fair light for sewing (1)	Poor light for sewing (o)	....	
	Kitchen well lighted (2)	Good light at sink or at range (1)	Poor light all parts of kitchen (o)	....	
	Lights both sides of mirror in bathroom (2)	Light on one side bath mirror (1)	No light near bathroom mirror (o)	....	
	No carrying of lights from one part of the house to another (2)	Necessary to carry light to some parts of the house (1)	Always necessary to carry light to rooms (o)	....	....
CONVENIENCE OF LIGHTING SYSTEM	Gas or electric wall switches (2)	Gas or electric control at light (1)	Oil lamps used (o)	....	
	Switch on one floor turns on light on other floors (2)	Switch control of light upstairs and down but not to cellar (1)	No switch control from different floors (o)	....	
	Extra electric or gas connections (2)	Some, but insufficient extra connections (1)	No extra connections (o)	....	
	Variation of light intensity possible in all rooms (2)	Variation of light intensity possible in few rooms (1)	Variation of light difficult in any room (o)	....	
	Lighting service never interrupted (2)	Service occasionally interrupted (1)	Service frequently interrupted (o)	....	....
GRAND TOTAL				PERFECT SCORE 50	

REFERENCE BOOKS

- Adams, *Harper's Electricity Book*. Harper and Brothers.
- Bachman, *Great Inventors and their Inventions* (Edison). American Book Company
- Barber, *First Course in General Science*, Chapter I. Henty Holt and Company.
- Brownell, *General Science*, Chapter X. Blakiston's Son and Company.
- Burns, *Great Inventions* (Electricity). Harper and Brothers.
- Clark, *An Introduction to Science*, Chapters XXVI, XXX. American Book Company.
- Gowin and Wheatley, *Occupations*, Chapter IX. Ginn and Company.
- Hodgdon, *Elementary General Science*, Chapters X, XI. Hinds, Hayden, and Eldredge.
- Inventor and Lamp* (Lecture 8). General Electric Lecture Service, Schenectady, N. Y.
- Official Handbook, Boy Scouts of America*. Doubleday, Page and Company.
- Lynde, *Physics of the Household*. The Macmillan Company.
- Smith and Jewett, *Introduction to the Study of Science*, Chapter IV. The Macmillan Company.
- Tappan, *Modern Triumphs* (Edison and Electric Light). Houghton Mifflin Company.
- Tappan, *Wonders of Science*. Houghton Mifflin Company.
- Van Buskirk and Smith, *The Science of Everyday Life*, Project XII. Houghton Mifflin Company.

CHAPTER XII

IMPORTANCE OF OUR EYES

Problems. — 1. *To find out how the eye resembles a camera in structure.*

2. *To find out what colors are.*

3. *To learn what the common defects of the eye are and how to remedy them.*

4. *To find out the defects of my own eyes.*

5. *To learn rules for proper care of the eyes.*

Suggested project. — 24. To remedy any eye defects I may have.

How we see. — Can you imagine any greater misfortune than to lose your eyesight and to live in the dark all the rest of your life? The daylight is not long enough for us, so we procure artificial light and keep our eyes at work part of the night also. We read fine print in dim light, and strain our eyes in a hundred different ways. The object of this chapter is to give us some idea of the structure and care of the eyes.

Demonstration Experiment. — To use a lens in focusing.

Materials: Double convex lens. White screen. Large carbon bulb.

Method: 1. *Focal length.* Hold a double convex lens in sunlight at right angles to the rays. Place a screen of white paper back of the lens and adjust the distance between them until the spot of light (the sun's image) is the smallest. The distance from the lens to the screen is called the focal length of the lens. Compare the focal length of a thick lens with that of a thin lens by this method.

2. *Focusing as it is done in the camera.* Hold a double convex lens about four times its focal length from a large carbon lamp which is lighted in a darkened room. Move a screen of white cardboard back and forth until a position is found where a sharp image of the filament is seen on it. Move the lens towards the light until a second sharp image results. Measure the distances approximately.

Observations: 1. How does the focal length of the thick lens compare with that of the thin one?

2. Make a drawing to show the positions of the lamp, the screen and the two positions of the lens which give sharp images. Describe these images.

Conclusion: A. Can lenses be used to produce clear images of objects? B. Can a lens be used to produce different sized images of an object?

Application: Explain how this experiment illustrates the use of a lens in the ordinary camera and also in the enlarging camera.

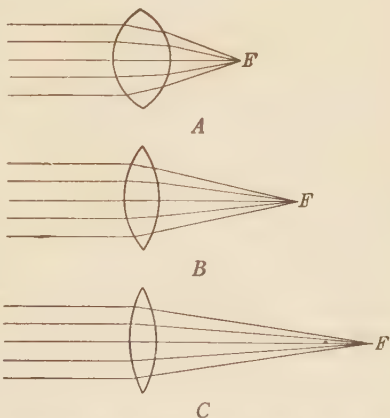
Lenses and what they

do. — An ordinary reading glass is a common example of a simple lens.

If we look at it in cross section, we find that it bulges outward in the middle on both sides and is called a *double convex*

lens. If we hold such a lens so that the sun shines through it, and move a piece of paper toward or away from it, one place will be found

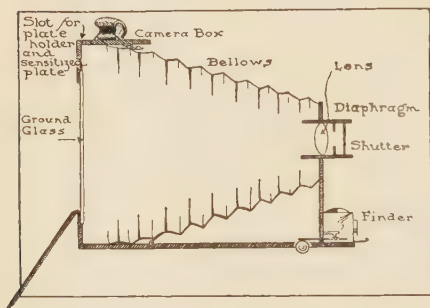
where only a tiny spot is lighted, but this will be extremely bright, and enough heat may be concentrated to set the paper on fire. This point at which the sun's rays have been brought together (see *F* in figure) is called the focus.



Which lens has the shortest and which the longest focal length?

Light passes through the air in parallel rays, but the double convex glass bends these rays so that they come together at one point. This point is called the *principal focus* of the lens, and the distance from that point to the center of the lens is called the *focal length*.

The camera. — The study of a camera will help us to understand the parts of the eye. If we carefully note the



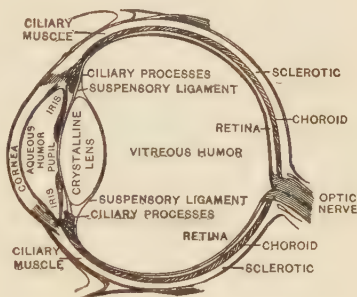
Essential parts of a plate camera.

parts of the camera shown in the illustration, we find that it is a light-tight box painted black on the inside to absorb all light rays, and having a lens, a diaphragm for changing the size of the opening, and a shutter in front which

controls the time of the exposure of the photographic plate or film which is placed at the opposite end of the camera. In a photographer's camera, such as is shown in the illustration, a ground glass is placed at the end where the plate is held when an exposure is made.

Structure of the eye. — Our eyes are among the most delicate and wonderful organs of the body. We abuse them constantly, yet they serve us faithfully. Notice how well they are protected from blows by being set in a bony socket, and how admirably the lashes serve to keep out dust and dirt. If dust gets upon the delicate membranes of the eye, how quickly the tears flow to wash it away. Observe also how the eye can be turned in different directions, due to little paired muscles which move the eyeball.

If we study a section made by cutting the eyeball in halves from front to back, we find that it is more like the camera inside than it is on the surface. In the front of the eye there is a transparent *lens* which makes a little picture at the back of the eye on the *retina*, just as the camera lens makes a picture on the film. This lens, however, is not fixed in shape like that of a camera, but is flexible, and is made thicker or thinner by the movement of delicate muscles, thus doing away with the necessity of moving the lens forward or backward in order to get a picture in focus. This change of focus is called *accommodation*. A



Section of the eye. Find the parts which correspond to those in a camera.

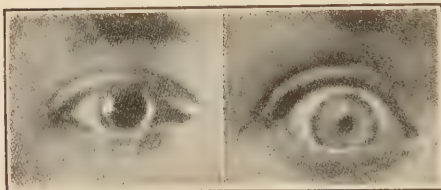
colorless substance, the *vitreous humor*, fills the space between the lens and the retina which is at the back of the eye and which receives the image and sends it to the brain. Covering the eyeball are two coats, outside of the retina. The outer one is tough (the *sclerotic*) and the middle coat is called the *choroid*. A portion of the choroid called the *iris* is filled with pigment and makes a curtain around the *pupil*, thus giving color to the eye.

Experiment. — To see the pupil of the eye change in size.

How the eye adapts itself to different intensities of light. — The eye is able to adjust itself to different amounts of light, within rather wide limits, without harm, by changing the size of the pupil. In order to avoid straining the

eye, it is necessary to have the right amount of light. Much harm is done sometimes when we are young by trying to read in insufficient light; just as much harm is done by looking into a blinding light, as for example trying to look at the sun when it is very bright.

It has been found that different intensities of light in



How does the eye adjust itself to different intensities of light?

the home are desirable for different kinds of work. The following table gives the intensity in foot candles, which means the amount

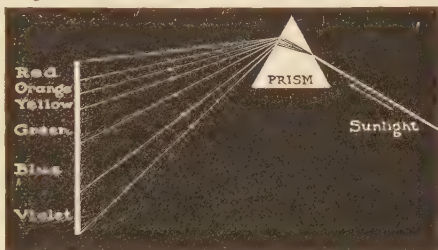
of light a candle would give at a distance of one foot from an object.

	DESIRABLE AT TIMES	MINIMUM
Hall and stairways . .	1 — 2.5 foot candles	0.5 foot candle
Living room and dining room	3 — 6 foot candles	1.5 foot candles
Sewing room	6 — 12 foot candles	3.0 foot candles

What is color? — Light is caused by waves of ether which come to us from the sun or from other lighted objects, but only a very small portion of them affect our eyes, and give us the sensation we call light. Ether waves producing light differ in length, the longest is one thirty-three thousandth of an inch in length, and the shortest that we can see, is one sixty-six thousandth of an inch in length. The longest of these visible waves causes the sensation of red, and the shortest gives the sensation of

violet, while all other colors come between them. *Color*, then, is a property of light waves, and each particular color is due either to waves of some particular length, or to mixtures of waves which produce different colors.

How we see color. — When all the different light waves from the sun are mixed together, white light is produced, as when sunlight is reflected by white paper. White substances are those which reflect sunlight. Black objects are those which absorb it. Any object which absorbs all the light waves except the very long ones is red, because it reflects only the red waves to your eyes. In the same way, any object which absorbs all the waves except the very short ones would look violet in color.

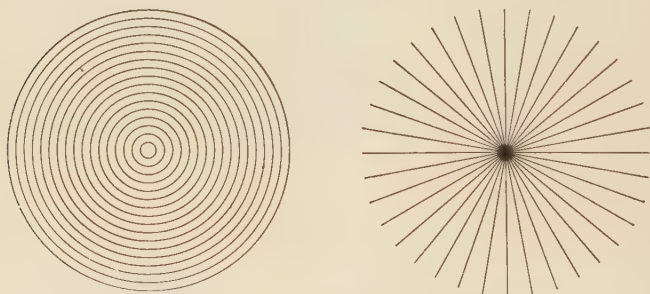


A prism separates white light into colors of the spectrum.

We can easily prove that light is made up of these various colors by passing a ray of sunlight through a triangular piece of glass called a prism which then shows all the rainbow colors of the spectrum. The rainbow is caused by nothing more or less than light passing through falling drops of water, which act as prisms, separating the light into its elements, red, orange, yellow, green, blue, and violet.

Some defects of the eye. — Although the eye is a wonderful piece of mechanism, it has several kinds of defects which are frequently found. Fortunately, due to a study of the eye and of the science called *optics*, we are now able

to remedy most of these defects very easily, usually by the use of glasses. It is estimated that one person in every four has some defect in vision. Nearly twenty-five per cent of the school children in Massachusetts and over thirty per cent of the school children in New York have eye trouble of some kind. The most common defect of the eye is *astigmatism*, which is due to a slight uneven curvature of the cornea, or of the lens. This can be detected easily by use of the diagram given below. Look at



Diagrams to be used in testing for astigmatism.

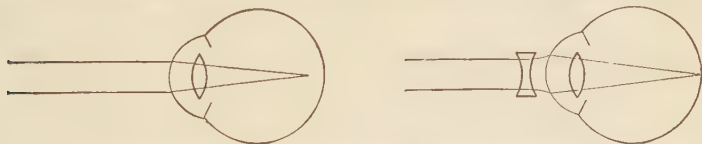
either of the figures with one eye closed. If some of the lines appear blurred or thicker than others, then astigmatism is present. It should be corrected with glasses, as this defect is a frequent cause of headache.

Another defect which occurs often is *nearsightedness*. In this case the eyeball is too long from front to back, or the lens is too thick, so that the image of distant objects is focused in front of the retina. This tends to make one squint, and also to hold objects near the eyes. Nearsightedness is quite common among children, and is easily corrected by the use of glasses which place the focus in the right place.



How the same things appear to one with normal vision and to one with astigmatism.

Farsightedness is another defect of frequent occurrence, in which case the eyeball is too short, or the lens too thin, and the image would focus behind the retina, giving only



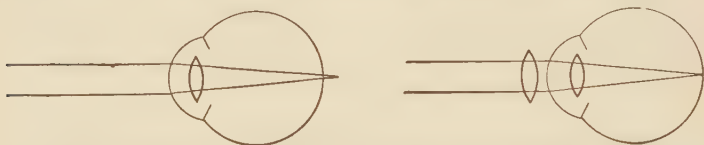
Nearsightedness is remedied by means of concave eyeglass lenses.

a blur on the retina. This is a more difficult defect to detect and people often are first made aware of its presence by constant headaches. As a person grows older, a tendency to become farsighted increases. It is frequently the case that elderly persons need one kind of lens for reading

and another for ordinary purposes. A double glass, called *bifocal*, combining the two lenses in one is often used under these conditions.

Experiment. — To test my own eyes for defects.

Correction of defects. — If you have eye defects, go at once to an oculist and procure glasses to correct them. If



Farsightedness is remedied by means of convex eyeglass lenses.

the eyes are red or inflamed or if water runs from them, or if the lids are sore, see a physician at once. Avoid doing fine work and reading in a bad light. If the eyes are painful cover with a cloth wrung out of very hot water. A two per cent boracic acid solution is an excellent



Turning the eyelid back to remove dirt.

eye wash, and so is a salt solution made of one teaspoonful of salt to a pint of boiling water. Dust or cinders may be removed by rolling the upper lid as illustrated in the diagram or by pulling

the lower lid down. Always use clean absorbent cotton or a clean handkerchief to remove dirt from the eye and follow with an eyewash.

Suggestions for the care of the eye. — Eyestrain frequently results from an effort of the eye to overcome its defects, and also from giving it too severe use, thus overtaxing the blood vessels of the eye, and the nerves, which in turn affect the nerves of the head and stomach. Following are some suggestions for the care of the eyes.

1. Do not sit so that direct light reflected from book, paper, or highly polished floors will cause a glare.
2. Do not sit facing strong artificial or natural light.
3. Do not sit so that your shadow falls upon your work.
4. Do not use a flickering light.
5. Do not read on a train or other moving conveyance.
6. Adjust the intensity of the light to your requirements. Strong light is needed to read fine print.
7. Do not use the eyes when they ache or when you are fatigued.

SCORE CARD. CARE OF MY EYES

	SCORE	
	Perfect Score	My Score
Use different intensities of light for different kinds of work (See table, page 178)	2.5	
Never look into "blinding" light	2.5	
Do not use flickering light for work	2.5	
Do not use dim light for reading	2.5	
Do not read on cars	2.5	
Correct position of light when reading. (No glare on paper; light from above)	2.5	
Correct position of light when writing. (Light over left shoulder for right-handed people)	2.5	
Do not read fine print for long periods of time	2.5	
Do not use too strong a light for reading. Lights that make glare are bad	2.5	
Never face strong light when reading or doing other fine work	2.5	
Strong light used for sewing or other fine work	2.5	
Do not use eyes when they ache	2.5	
Do not use eyes when tired	2.5	
Bathe eyes in hot salt water if they ache	2.5	
Wash frequently in boracic acid if inflamed	2.5	
Can remove dirt by rolling lid.	2.5	
Eyes examined by oculist once a year	2.5	
Glasses adjusted by <i>oculist</i> , when needed	2.5	
Glasses used constantly in case of eye defects	2.5	
Eyes tested and found glasses not needed	2.5	
TOTAL	50.0	

REFERENCE BOOKS

- Allen, *Civics and Health* (For teachers), Chapter VII. Ginn and Company.
Broadhurst, *Home and Community Hygiene*. J. B. Lippincott Company.
Brownell, *General Science*, Chapter I. Blakiston's Son and Company.
Clark, *Introduction to Science*, Chapters XXVI, XXVIII, XXIX. American Book Company.
Hodgdon, *Elementary General Science*, Chapter X. Hinds, Hayden, and Eldredge.
Hunter, *A Civic Biology*, Chapter XXIII. American Book Company.
Hunter, *Laboratory Problems in Civic Biology*, Chapter XXIV. American Book Company.
Ritchie, *Physiology and Sanitation* (Chapter on Eye). World Book Company.
Routledge, *Discoveries and Inventions of the Nineteenth Century*, pages 374-402; 529-551. Routledge.
Stiles, *Human Physiology*, Chapter XI. W. S. Saunders Company.
Thompson, *Boys' Book of Sports*, pages 291-301. The Century Company

PART V. HELPFUL HOME EQUIPMENT

CHAPTER XIII

SIMPLE MACHINES USED IN THE HOME

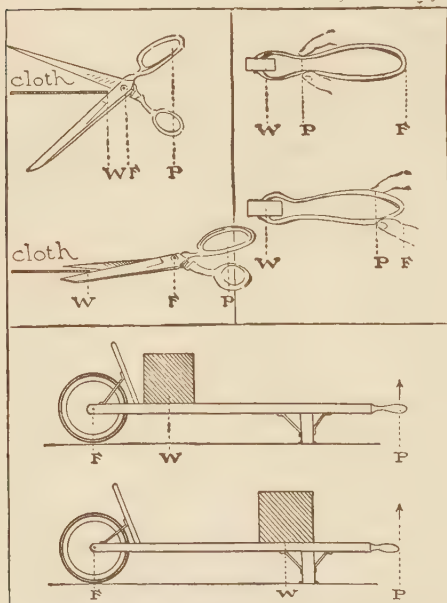
Problems. — 1. *To understand the principles underlying simple machines used in and about the house.*

2. *To understand what advantages machines offer.*

Suggested project. — 25. To keep the machines of the home in good working condition.

Why we use machines in our homes. — If you could see a home as it was one hundred years ago you would find very few labor saving devices in it. Most of the work was done by hand, with the assistance of a few simple machines, such as churns, spinning wheels, wagons, and the like. This is an age of machinery, we save time and energy by using machines of many kinds to do our work for us. Machines are much more efficient than we are, they work more quickly and do not make mistakes, and so each year we find new labor saving devices invented for use in our homes. It is a wise housekeeper who can select from the multitude of machines now offered in the market those which are economical, serviceable, and durable. It is the purpose of this chapter to point out a few of these machines, and to try to explain the simple principles which underlie their construction and operation.

Two types of machines used in the home. — The lever and the wheel and axle are the two types of simple machines which are most important in the construction of many household devices. A pair of shears is made of two pieces of metal, held together at one point by a rivet with



In which of each of these three cases will the same resistance be overcome by a smaller force? P = force.
 W = weight (resistance). F = fulcrum.

the inner edges sharpened at an angle. If we try to cut a piece of thick cloth with these shears, we find it much more difficult to cut the cloth when it is placed at some distance from the point where the parts of the shears are rotating, while it cuts easier close to the point of rotation. The shears illustrate the lever type of machine, the force we exert being

called the *force*, the resistance we overcome in the cutting of the cloth the *weight*, since it is measured in units of weight, and the point at which the shears revolve, or turn, is called the *fulcrum*. With the sugar tongs, which is a lever also, it is much easier to hold the lump by placing the fingers close to it than it is to apply the force

far away from it. Another type of lever is the wheelbarrow.

Experiment. — To demonstrate the principle of the lever.

Three classes of levers. — There are three classes of levers which depend on the position of the fulcrum, the weight, and the force. The relative positions of these are as follows: In levers of the first class, the fulcrum comes between the weight and the force; in levers of the second class, the weight comes between the fulcrum and the force; in levers of the third class, the force comes between the weight and the fulcrum. The shears belong to the first class of levers, the wheelbarrow to the second class, and the sugar tongs to the third class.

Mechanical advantage. — We use a machine ordinarily to overcome a force greater than that which we apply. If by means of a machine we can lift 200 pounds by applying a force of 25 pounds, then the mechanical advantage of the machine is 8; it is equivalent to the weight moved divided by the force applied. This is represented by the formula —

$$\text{Mechanical Advantage} = \frac{\text{Resistance (Weight)}}{\text{Effort (Force)}}$$

With levers of the third class we must apply more force than the resistance to be overcome. Then why use such a machine? The advantages of levers of the third

class is that a greater speed is obtained or a longer distance covered. This is well shown in the forearms (see

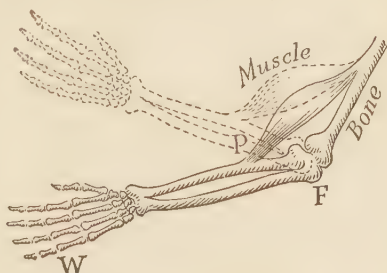
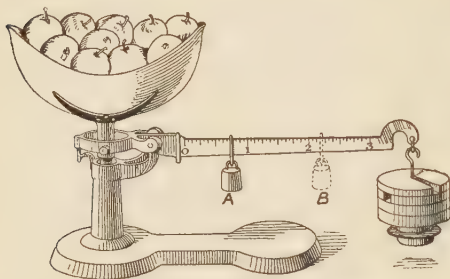


illustration) where by shortening the muscle one inch the hand may be moved a foot. Great speed of movement is gained also.



Principle of the lever used in weighing.

How we weigh things. — Most of the scales which are in use depend on the principle of the lever. On the scales in the picture, would you get more or fewer apples if

the sliding weight were placed at point A or at point B? Explain why.

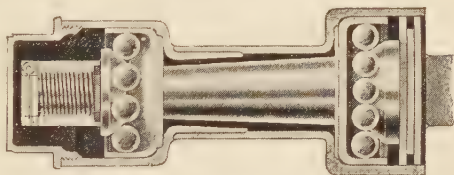
The lawn mower. — If you have pushed a lawn mower along a level lawn, you must have noticed that the force you applied is distributed in two directions. You push the lawn mower forward, and you push it downward also. This downward motion is applied in increasing the pressure of the wheels against the ground, causing them to turn around without sliding. The horizontal force is used in moving the lawn mower forward, and also in turning the wheels. If you push a lawn mower upside down, so that the revolving knives do not hit the grass, you will notice that it runs more easily. A large part of your energy, then, goes in moving these knives, which are retarded by pressure against the grass and the



The push (B) is divided into two parts: force A downward, which gives the necessary friction for the wheels to turn, and force C, which rotates the blades and moves the mower forward.

lower part of the lawn mower. If two boys work together in cutting a lawn, the task is made much lighter by one boy fastening a long rope in front of the mower and pulling. Explain why this is so.

Wheels and runners. — Why do our wagons have wheels and our sleds runners? Perhaps you know that when we move one body over another, a certain amount of resistance known as *friction* must be overcome. Have you ever pulled with all your might to drag a heavily loaded box over the floor and found how easily it could be pulled after placing one or more rollers, such as can be made from a broom handle, under the box? In much the same way a load on a wagon is moved over the bare road more easily than the



Ball bearings.

same load on a sled. The sled runner slides over the road surface, while the wagon wheel rolls over it; and *sliding friction* is greater than *rolling friction*.

Smooth surfaces as glass, ice, and well-worn snow have very little resistance to the movement of hard objects over their surfaces. Therefore in winter when snow covers the ground, we use runners, which have many points of contact with the surface and do not sink into depressions in the snow as wheels do.

Unit of work. — The term we use for the unit of work is the *foot pound* or, as its name indicates, the amount of force necessary to lift a pound one foot. If four pounds are lifted four feet from the ground, sixteen foot pounds of work is done. In other words, *the work equals the weight*

multiplied by the distance. Work is done in overcoming friction between two bodies as well as in overcoming gravity. In this case the work done is equal to the *resistance* times the *distance* through which the resistance is overcome.

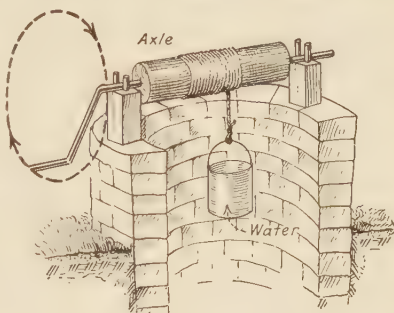
The law of machines. — Machines do not *make* energy. They simply *transfer* force or mechanical energy from one place to another. We shall see as we go on in our study of science that *energy* is simply the *ability to do work*. Sometimes this energy is locked up in substances, as in coal, which gives heat when burned, or it may be evident as in the power in the running stream, or in the waves, or in the wind. By the use of a machine we transfer this energy or power from one place to another, and by this means get work done more effectively. The chief value of machines lies in their enabling us to overcome a large resistant force by applying a small force. But we must remember that we get no more work out of a machine than we put into it. For example: if a force of 20 lbs. on the long arm of a lever or on the rope of a pulley, acts through a space of 10 ft. a weight of 200 lbs. on the short arm of the lever or on the pulley would be moved through a space of 1 foot with the same force.

Force $\times$ distance = work = weight $\times$ distance

$$20 \times 10 = 200 \text{ ft. lbs.} = 200 \times 1$$

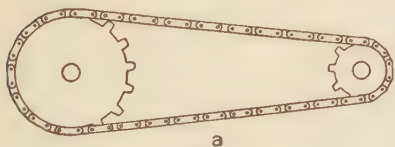
The application to some other machines. — If we apply this rule to such machines as the windlass, meat chopper, clothes wringer, coffee grinder, and ice cream freezer, we find that we can easily estimate the amount of force which must be exerted to get the work done. In the machines just mentioned, we apply force by means of a handle which is moved through a circular path and we call them the crank and axle, or the wheel and axle type.

In the windlass, which is one of the simplest to understand, let us suppose the handle moves through a circle 64 inches in circumference. While the handle makes this movement the rope winds once around the axle, the circumference of which is 16 inches. In this way the weight, a pail of water, is lifted 16 inches while the force is moving 64 inches. What is the mechanical advantage of this machine? How much force must be applied to raise a pail of water weighing 32 lbs.?

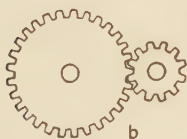


The windlass.

Wheels of different diameters connected by belts or interlocked by gear teeth are used for the purpose of changing speed as well as for securing a mechanical advantage. A study of a few home machines will make this apparent and explain the purpose of their use.



a



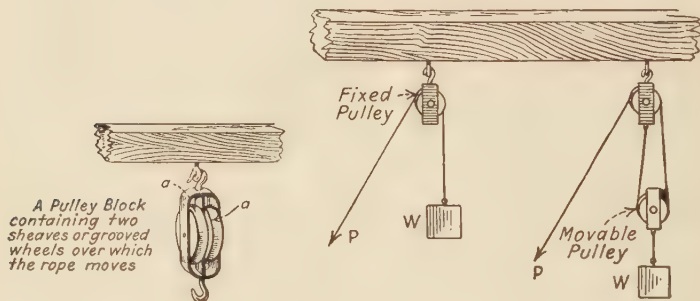
b

Gears are used for changing speed.

Experiment. — To see how speed is changed in machines.

The pulley. — The “block and tackle” is a common and useful device. It consists of a block which remains in a fixed position called the “fixed” pulley, and one which moves with the

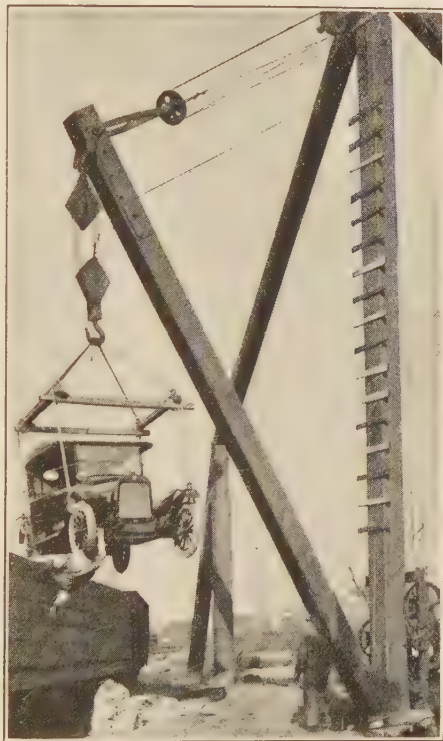
object lifted called the "movable" pulley. The blocks may have one or more movable sheaves in them which rotate under the rope. The fixed pulley, used alone, gives no mechanical advantage. It does, however, give one the advantage of applying the force in the opposite direction from that in which the load is being moved. A movable pulley consisting of a single sheaf gives a mechanical advantage of two. You will readily understand this by



considering the movable pulley wheel a lever of the second class. (See diagram.)

In the block and tackle we have a more complicated problem, resulting from the use of both movable and fixed pulleys, but it has been found that the mechanical advantage is always equal to the number of ropes coming from the movable pulley. Suppose you see men hoisting a piano up to the second story window of a house. There are three sheaves in the upper pulley with two in the lower one and one end of the rope tied to the lower or movable pulley. Upon counting you find the number of cords or ropes from the lower pulley is five. Hence, a man would need to exert one hundred pounds to support a piano weighing five hundred pounds.

The inclined plane. — A very simple but useful tool used by the truckman is the *skid*, with which he makes easy work of unloading heavy boxes and barrels from his truck. The skid is useful in loading also. How much easier it is to go up a long, well-graded road than to take a short cut and climb a precipitous path to the top of a hill! For the same reason it is easier to roll a barrel of flour up an inclined surface than to lift it vertically to the same height. The skid is one example of a type of a simple machine called the *inclined plane*. Other examples are



Use of fixed and movable pulleys.

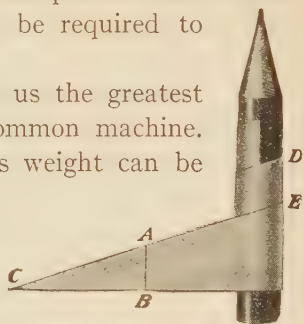
the axe, the hatchet, the wedge, needles, and pins.

The relation of force to weight for different heights and lengths of the incline has been carefully determined by experiment and is as follows:

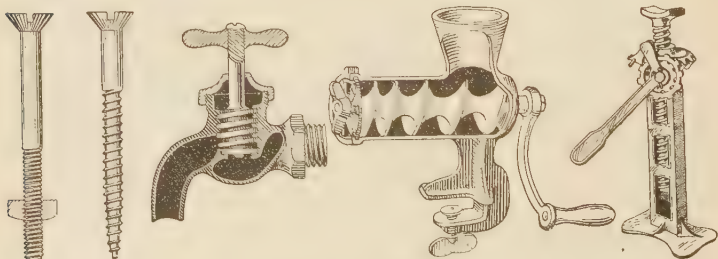
$$\begin{aligned} \text{Force: Weight} &:: \text{Height: Length} \\ \text{Force} \times \text{Length} &= \text{Weight} \times \text{Height} \end{aligned}$$

Calculate how much more force would be necessary to draw a load of coal weighing 3000 pounds over a road having a 3% grade than would be required to draw it if the road were level.

The screw. — The screw gives us the greatest mechanical advantage of any common machine. By its use buildings of enormous weight can be raised. Many of you know how easily a heavy automobile is lifted by means of an auto jack. The screw is a cylinder having a spiral inclined plane on its surface and capable of being turned by means of a lever. The lever may turn in a horizontal circle as in the jackscrew or by means of bevel gears as in some of the auto jacks which permit an up and down motion of the lever. In one complete turn of the screw the load is moved a distance equal to that be-



Observe how the screw is in reality a spirally inclined plane. Explain diagram.



Illustrating the use of the screw.

tween two consecutive threads known as the *pitch* of the screw. By measuring or calculating the distance the force moves in turning the screw once you can calculate the mechanical advantage of the machine.

The sewing machine. — A great many other types of machines can be found in our homes, but one almost always present is the sewing machine. These machines have been improved so much since 1850 that their work is now extremely rapid and efficient. A study of the part that does the stitching is somewhat too complex for us at the present time, but would make a very interesting home project which could be studied by means of diagrams furnished by almost any good machine supply house.

The small vacuum washer. — A small hand washer using the vacuum principle does good work. It has a cone-shaped metal washer with holes in the sides fastened to a handle and the large end open. If this washer is pushed down and lifted up alternately with a great deal of vigor, air will be forced out on the down stroke, and the vacuum produced on the up stroke sucks the water up through the clothes under the washer. The use of such an instrument as this is very effective in washing big, heavy blankets or delicate materials which may be injured by rubbing. What is the explanation of suction?

Washing machines. — Washing machines are of two kinds as far as the inside operation is considered. In one, the system of vacuum domes is similar to the one just described and is operated mechanically inside of a closed tub. In the second type the clothes are held in a perforated drum which sets in water held in an outside container. As this drum revolves first in one direction and then in the other, the constant whirling of the water back and forth and through the clothes washes them. This machine may be operated in a number of different ways, as by hand lever, crank, water motor, or electric motor. The hand-operated machines are very efficient, but re-

quire time and attention. The motor-driven ones are much more expensive, but save much work

REFERENCE BOOKS

- Bachman, *Great Inventions and Their Inventors* (Sewing machine). American Book Company.
- Barber, *General Science*, Chapter X. Henry Holt and Company.
- Black and Davis, *Practical Physics*, Chapter II. The Macmillan Company.
- Brownell, *General Science*, Chapter VII. Blakiston's Son and Company.
- Caldwell and Eikenberry, *General Science*, Part III, Chapters XV, XVI. Ginn and Company.
- Central Scientific Company, Chicago, *Catalogue* with illustrations of simple machines for projects.
- Child, *The Efficient Kitchen*, Chapters II, XIV (For teachers). MacBride, Nast and Company.
- Clark, *An Introduction to Science*, Chapter XXXII. American Book Company.
- Clark, *The Care of a House* (For teachers). The Macmillan Company.
- Carhart and Chute, *Physics with Applications*, Chapter VI. Allyn and Bacon.
- Fall, *Science for Beginners*, Chapter XXXIII. World Book Company.
- Hessler, *The First Year of Science*, Chapter X. Benj. H. Sanborn Company.
- Hoadley, *Essentials of Physics*, Chapter III. American Book Company.
- Hodgdon, *Elementary General Science*, Chapter XIV. Hinds, Hayden and Eldredge.
- Knott Apparatus Company, Boston. *Catalogues* with illustrations of simple machines for projects.
- Lynde, *Physics of the Household*, Chapters I, II, III. The Macmillan Company.
- Singer Sewing Machine Company, *Mechanics of Sewing Machines*.
- Van Buskirk and Smith, *The Science of Everyday Life*, Project XV. Houghton Mifflin Company.
- Van Rensselaer, *Manual of Home Making*, Chapter III (Teachers' use). The Macmillan Company.
- Williams, *How It Works*. Nelson Company.

CHAPTER XIV

ELECTRICITY IN THE HOME

Problems. — 1. *To learn the properties of magnets and how magnetism is produced by electricity.*

2. *To see how electricity is produced from chemical energy in electric cells.*

3. *To understand the working of electric bells and how to install them.*

4. *To find out how a simple motor works.*

5. *To see how electricity gives heat.*

6. *To find out what effect different lengths and sizes of wire have on the electric pressure and current.*

7. *To find out how the house is protected from excessive currents.*

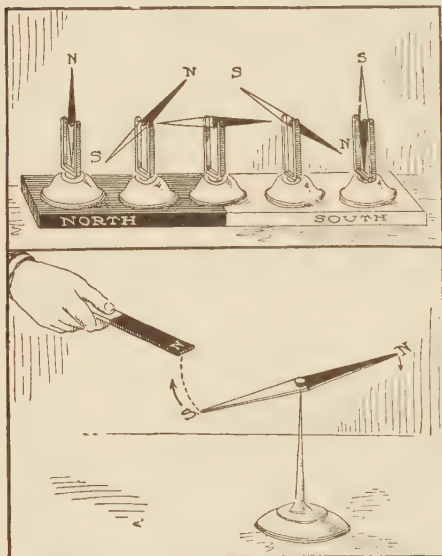
8. *To learn how to read the electric meter.*

Suggested projects. — 26. To install an electric bell.

27. To install a night light in a bedroom.

Electricity in the home. — Most of us know that the harnessing of electricity to become a servant of the household has been comparatively recent, and that we are just at the beginning of an era of electricity and electrical devices. Modern houses, if well equipped, have many of these labor saving and useful appliances such as the electric door-bell, motor, and iron. The bell and the motor depend upon electromagnetic action to do their

work, while the iron depends upon the heating effect of the electric current. In order to understand even a little about electromagnetic devices, it is necessary to know something of the properties of electricity, and its relation to magnetism.



What law of magnetism is illustrated here?

steel with a natural magnet, by holding it near one, or by passing an electric current through a coil of wire which surrounds the steel.

Experiment. — To determine laws of magnetic poles.

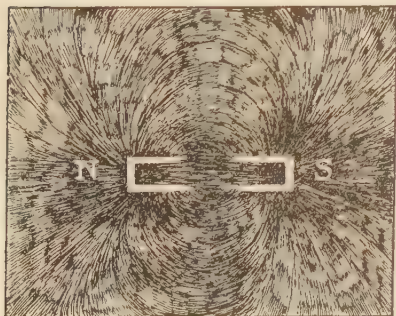
The properties of magnets. — Magnets attract not only unmagnetized iron but steel, nickel and cobalt as well. It is found that this attractive force is greatest at two points near the ends of the magnet called the *poles*. Half-way between the poles is the magnetic equator, a region of

Magnets. — A great many years ago, a kind of iron ore was found in Magnesia, Asia Minor, which had the property of attracting other pieces of iron to it. The name magnet was derived from the name of the country in which it was first found. Artificial magnets can be made by rubbing a piece of

practically no magnetic attraction. If a magnet is suspended so that it swings freely in a horizontal plane, its poles take a north and south direction. If we bring the north pole of one magnet near the north pole of a suspended magnet, the freely moving north pole swings away. If we bring the south pole of a fixed magnet to the north pole of a movable one, the south pole is drawn toward the north. These results invariably happen when two magnets are brought together, and from them we are able to state the law. *Like magnetic poles always repel, and unlike magnetic poles always attract, each other.*



The magnetic strength is greatest near the ends.



A magnetic field. Iron filings scattered over a magnet arrange themselves in the lines shown.

Experiment. — To magnetize an iron bar in the field of another magnet and in the earth's magnetic field.

The magnetic field. — Have you not noticed tacks or iron filings jump across an air space to a strong magnet? A compass needle will turn when several feet away from

a strong magnet. These facts indicate that the influence of the magnet spreads out for some distance and in all direc-

tions. This space around a magnet in which magnetic influence exists is called the *magnetic field*. Every magnetic field has *magnetic lines of force* which give the direction of the magnetic force at each point. It is because the earth itself is a huge magnet and has a magnetic field surrounding it that the compass needle takes a definite direction.

Demonstration Experiment. — To make a magnet by using the magnetic field of another magnet or of the earth.

Materials: A three-inch length of soft iron. A strong bar magnet. A three-foot length of iron gas pipe or soft iron rod. Compass. Dipping needle. Fine iron filings. Hammer.

Method: (A) Test the three inch iron rod by dipping it in iron filings. If it shows no magnetic effect, place one end of it very near to one pole of the bar magnet. Tap it two or three times with the hammer. Now test it in the iron filings to see if it has become a magnet. (B) Test the iron gas pipe by holding first one end and then the other near the north end of the compass needle. If both ends attract the north pole of the needle it is *not* magnetized and is ready to use. If one end attracts while the other repels, its magnetism must be removed. This may be done by holding the pipe horizontally in an east and west direction and striking it with the hammer. After a few trials you will find that its magnetism has disappeared. The compass indicates the north and south direction. Place the dipping needle so it is free to swing in this plane. Hold the gas pipe in a position parallel to the dipping needle and strike one or two blows on the end with the hammer. Test to see if the pipe now is a magnet by holding first one end and then the other near the compass needle.

Observation: What are the results in (A) and (B)?

Conclusion: What is one way of magnetizing substances? Why does the dipping needle take the direction that it does? Why point the gas pipe in that same direction?

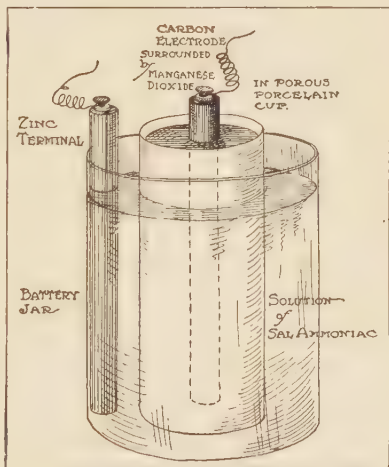
Application: Why do tools standing in one place in the house for a long time sometimes become magnets?

Magnetic property of an electric current. — If a wire connecting the two poles of a dry cell is brought down over a compass in a north and south line, the needle will move just as it would if we brought another magnet near

it. This is evidence that a magnetic field surrounds the wire. If the wire is coiled by winding a close layer on a lead pencil and a current sent through it the wire will act like a magnet with two poles. If a bar of soft iron be slipped inside of the coil, it will act as before, but with far greater strength. A device of this sort is known as an electromagnet. The magnetic property of an electromagnet ceases the instant the electric current is shut off, and appears again when the current is turned on.

Sources of current electricity. — If wax is rubbed rapidly with a woollen cloth it becomes charged with electricity which is said to be at rest and is called static electricity. An insulated conductor such as a radio aerial may be charged with static electricity but if the aerial is joined to the earth by a conductor the static electricity flows away as current electricity. Current electricity is merely electricity in motion and may be produced by means of electric cells and electric generators.

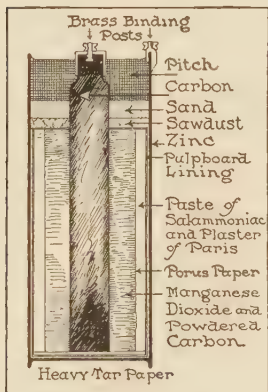
Electric bells. — You may have heard the terms dry cell and wet cell, as these two kinds of cells are used frequently to ring electric door-bells. The wet cell is made by nearly filling a jar with a saturated solution of *sal ammoniac*. In this a large carbon plate



The sal ammoniac (wet) cell.¹

and a *zinc* rod are suspended side by side but not touching each other. Electricity is formed at the expense of chemical energy, and the zinc rod which is destroyed must be replaced from time to time.

In the dry cell, the zinc used is placed on the outside of the cell while the carbon is a large rod in the center. Be-



Section of a dry cell.

tween these are the chemicals, a paste of sal ammoniac being placed next the zinc, and a layer of *manganese dioxide* around the carbon. Dry cells, because they are more convenient to handle, have replaced to a large extent the wet cells in our homes.

For the usual house circuit two cells will be ample and they should be joined, carbon (inside pole) of one to zinc (outside pole) of the other.

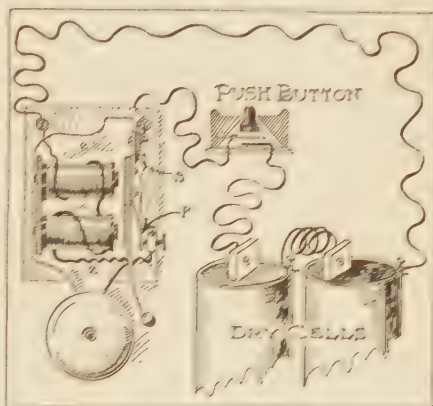
Where electricity is used for lighting it is possible to use it for the door-bell system also by installing a special device called a *transformer* for reducing its pressure. A transformer for bell ringing circuits can be bought for one or two dollars. The cost of operation is about the same as for renewals of batteries in the older systems

Experiment. — To demonstrate the electric bell.

The electric bell and how it works.—An electric bell consists of the base support, binding posts, electromagnet, armature, hammer, spring, contact post, and gong. A strip of platinum on the armature makes contact with a

platinum point on the contact post. These two pieces of platinum are held in position touching each other by the spring when no current flows. The wires from the battery and button are connected to the two binding posts; when the button is pressed the circuit is closed and the current goes to the spring and armature, to the contact post, to the electromagnet, and thence back to the other binding post.

Thus a current flows through the entire circuit. The electromagnet attracts the soft iron armature and pulls it away from the contact point at *P*, making a gap or break in the circuit.



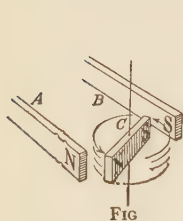
The electric bell system.

The current instantly stops, the magnetism disappears, the spring (*S*) brings the armature back and closes the circuit, a current flows again, and everything is repeated. This backward and forward movement of the armature causes a similar vibration of the hammer which strikes the gong on every pull of the magnet.

Other magnetic devices. Another electromagnetic device is the motor. Its importance can be appreciated when one realizes the amount of hard labor that is replaced by motor driven washing machines, ice cream freezers, grinding wheels, sewing machines, vacuum cleaners, and ironing machines. They are inexpensive for

the amount of work they do, and save the strength of the housekeeper for other important duties. The telephone, which has become a necessity in most households today, includes electromagnets as well as other complicated electrical devices in its equipment.

A simple type of motor. — Suppose we place two magnets *A* and *B* a few inches apart, with unlike poles opposite each other, and arrange a third magnet *C* on a pivot between one pair of poles of *A* and *B*. If we turn the magnet *C* so that its north pole is near the north pole of *A* and its south near the south pole of *B*, we find that it



FIG

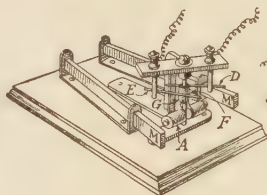


FIG. 2

Simple type of motor.

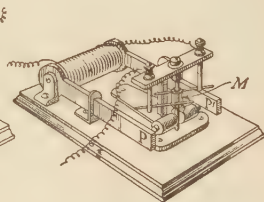


FIG. 3

rotates until the south pole of *C* is near the north pole of *A*. If we could now change the polarity of *C* so that its south became a north and its north, a south, then repulsion of the north pole of *C* by the north pole of *A* and the attraction between the north of *C* and the south pole of *B* will send *C* around another half revolution.

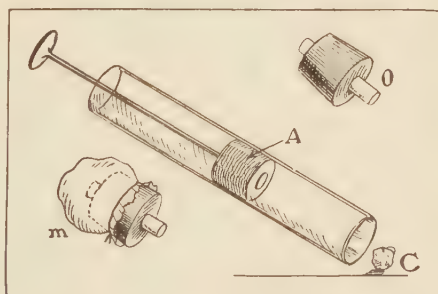
By reversing the poles of *C* every half revolution continued rotary motion can be secured. There is no practical way of reversing the poles of a permanent magnet to secure this rotation, but an electromagnet may have its polarity reversed by merely changing the direction of the current in the wire. In figure two, *D* and *E* are fixed "brushes." Current comes to *D*, passes through the coil of

wire of a rotating electromagnet and passes off through *E*. The ends of the coil of wire of the electromagnet are attached to two pieces of thin sheet copper which are insulated from each other. During one half the revolution *D* is in contact with *F*, and during the other half revolution it is in contact with *G*. When a north pole of the revolving electromagnet (the *armature*) has reached the south pole of the field magnet the current is automatically changed, and what was the north pole becomes a south pole.

In order to make the action stronger the magnets *A* and *B* may be replaced by electromagnets. We then have the essential parts of the commercial electric motor (Fig. 3): a strong magnetic field across the poles of the magnets (*P* & *P'*), a revolving armature consisting of a soft iron core surrounded by a coil of insulated wire, and a commutator (*M*) which is a metal ring divided into two or more parts insulated from each other. The ends of the armature coil are attached to these segments of the commutator. The brushes, which are fixed, make contact with the different segments of the commutator as the armature revolves. Current is brought to the brushes of the motor and rotation of the armature results.

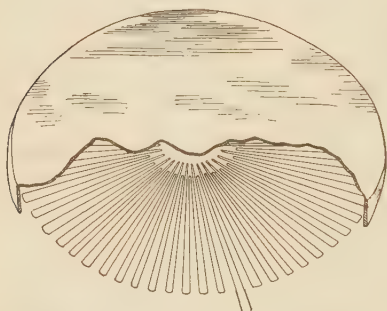
Vacuum cleaner and sweeper.—

The electric vacuum cleaners are of two types. One produces a vacuum by means of an air pump of the piston type, the other by means of a fan.



To show the principle of vacuum cleaning.

The principle of vacuum cleaning is demonstrated (p. 205) by holding the end of a glass tube near a loose ball of paper (C) and drawing up the piston (A). A vacuum is produced in the tube, and air rushing into the tube pushes the paper along with it. If the opening (O) is made smaller by using a stopper with a small tube, sand may be forced into the tube. A piece of muslin cloth (M) fastened



Showing the resistance wires in an electric stove.

over the inside of the stopper near the end of the larger tube will hold the sand and dirt which enters, but will allow the air to pass on.

Electric heating devices. — Many modern homes now are equipped with electric toasters, grills, coffee percolators, chafing dishes, heating pads, curling irons, and flat-irons, even with water and room heaters, and electric ranges. The principle of electric heating is practically the same in all of them. All conductors resist the flow of electricity and the electrical energy used in overcoming this resistance becomes heat. Some metals, like German silver and nichrome, offer much greater resistance than copper does. For that reason a short length of nichrome wire gives as much heat as a



Electric iron.

longer copper wire of the same diameter. You remember when studying about electric lights how a long wire was heated by an electric current. When the wire is in position in the base of a flatiron it is covered with an enamel which is baked on so that the wire cannot move out of position or touch other parts of the iron. The heating element of the coffee percolator and other devices

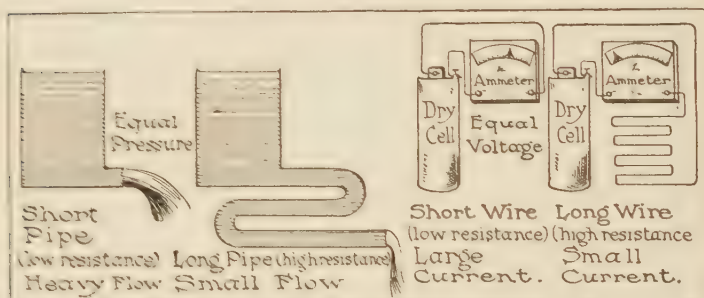


An electrically prepared meal. What heating devices do you see?

is made essentially in the same manner. The electric iron should have a switch close to the iron, also on its wall socket attachment a pilot light which will always glow when the current is on. Many fires are caused every year by carelessness in leaving the current in the electric irons when they are no longer in use.

Wire resistance to electricity. — A tank of water can be emptied more quickly with a short pipe than with a

long one of the same diameter because the long pipe has more surface to rub against the flowing water, and produces greater friction, thus allowing less water to get out in a given time. There is a very close parallel to this in the case of electricity passing through wires. If you connect the poles of one cell with a long wire and the poles of another cell with a short wire of the same diameter, more electricity will be discharged through the short than through the long wire. The reason for this is that



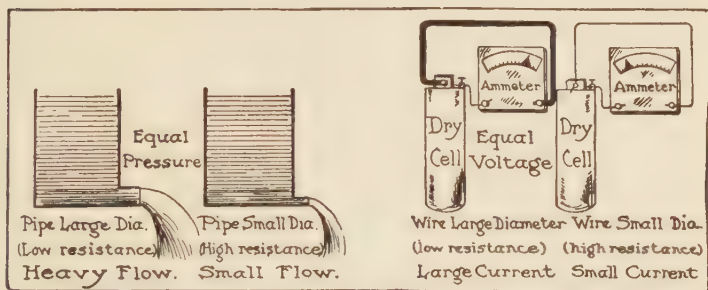
Water analogy: short and long wire resistance.

the longer wire offers greater resistance to the current, so that less current flows but as in the case of the tank of water, the current will flow for a longer time.

A pipe of large diameter will empty a tank of water much quicker than one of small diameter because it carries a larger volume of water than the smaller one. Just so with electric currents. The wire with a large diameter permits a larger flow of electricity than one of small diameter.

Electrical pressure. — Suppose you have two tanks of water, one holding a large amount, and the other a small amount and that the water in them is kept at the same

level. The water running from the faucets at the bottom will have the same pressure just so long as the level is maintained evenly in the two, and if the openings of the two faucets are of the same size, equal streams or currents of water will flow from them. The electrical pressure (called *voltage*) is independent of the size of the cells used. The cell of a small flashlight may have just as high *voltage* as does a common dry cell which has a pressure of about 1.5 *volts*. A *volt* is the unit used in measuring electric pressure, or the force which causes electricity to flow



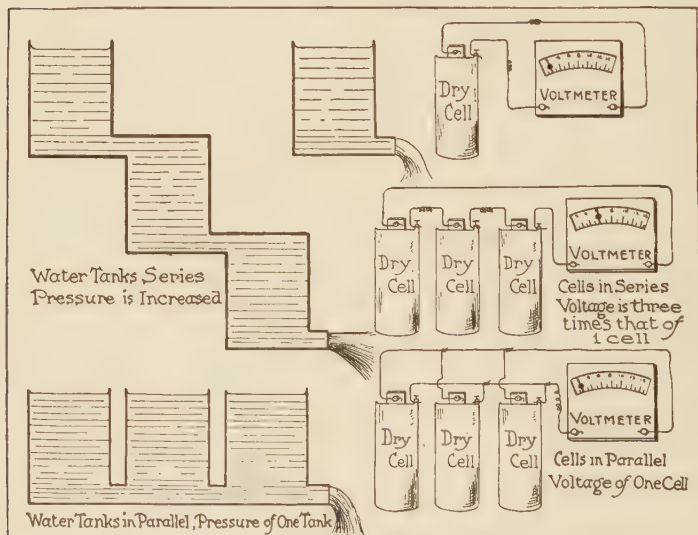
Water analogy: relation of current to resistance in large and small wires.

through a conductor. An instrument for measuring voltage is called a *voltmeter*.

Electric current. — If we use our tank again for comparison, we see that water pressure alone will not tell us how great a flow may be obtained. The size and length of the pipe help to determine this, because they regulate the resistance, and resistance is one factor which determines the amount of water which flows. This holds also in a similar manner with electricity. If we have the poles of a cell connected by a wire of small resistance, a large current will flow through it, but if the resistance is great,

a small current will flow. The unit for measuring an electric current is the *ampere*, so named after a French scientist. The instrument by which this current is measured is the *ammeter*.

How to join cells for use in the home. — There are two ways in which we may join cells together so that we



Water analogy to illustrate joining cells in series and in parallel.

overcome the resistance offered by wires. These are in *series*, and in *parallel*. We can understand these terms best by referring again to our water tanks. Suppose we have three tanks of water at the same pressure, and connect them so as to get a water column three times as deep as that of a single tank. The water pressure will be three times that of a single tank. If we join three cells *in series*, that is, zinc to carbon, and connect a voltmeter in

the circuit, we shall find three times as much pressure recorded as when a single cell is attached to the voltmeter. A high pressure (high voltage) will give us a larger current (in amperes) through the bell, motor, or light than we can get from the low pressure. When long wires are used in connecting an electric bell greater voltage is required to overcome the resistance of the long wire. This increased voltage can be obtained by putting in one or two more cells joined in series. A bell can be made to ring louder and a motor to run faster by this same method.

When we join our three tanks of water at the same level, we increase the capacity to furnish a current of water, although it has no greater pressure than the single tank. We may join three cells *in parallel* by connecting all the zinc poles to one wire, and all the carbon poles to another wire, and then join these two wires where we wish to use the current. If we attach a single cell to the voltmeter and read the voltage, and then later attach three cells joined in parallel to the voltmeter and read the voltage, we find it to be the same. Any number of cells joined in parallel have just the same voltage as a single cell. With the same size of opening for the single and the triple water tanks the water would flow from the triple tank for a longer time. It has a larger reservoir. Thus with the cells joined in parallel, if the voltage of one cell gives all the pressure you need, you can get much longer service from several cells joined in parallel than you can from one cell. These explanations should serve to make it possible for you to now use the batteries in your own home intelligently.

What is a "short circuit"? — The circuit of electricity is the complete path which the current must take from the cell out around the wire, through the bell or other instru-

ment, and back to its starting point. Let us, for example, take the lighting system in our home. The current is brought into the house by one wire, and returns to its source by another. If in the diagram, *A* and *B* connect our house supply with the city supply, when the switch is closed we are able to light any one or all of the lights *L*, *L'*, *L''*, and *L'''*. These lamps have a high resistance to electricity, and allow not more than one to three amperes of current to flow through the circuit. Now suppose the bare

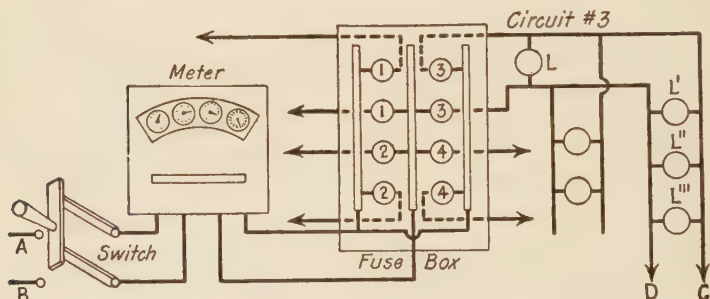


Diagram of a lighting system, showing four circuits from the fuse box.

ends of the wires *C* and *D*, which have low resistance, are brought together. This would cause a "short circuit" which would reduce the resistance several hundred times, and the current would be increased enormously.

There is a real danger from short circuits for they may not only burn the insulation of wires off, but set the building on fire also. If any part of the wire *AC* is connected metal to metal with any part of *BD*, or if the two separated metal parts of the lamp circuit be joined by a piece of metal, a short circuit results, with its great increase of heat and corresponding danger from fire.

Demonstration Experiment. — To demonstrate the use of fuses.

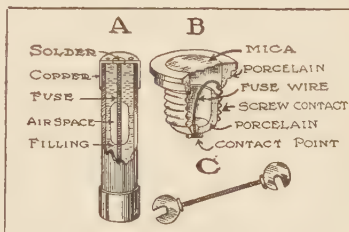
Materials: Small fuse wire (3 ampere). Also 10 ampere fuse wire. Four 25 watt incandescent lamps, four 100 watt lamps, four sockets, and connecting wires. Fuse block holding four binding posts for connecting fuse wire.

Method: Put a 3 ampere fuse wire into the circuit where connection is made to the lighting circuit. (a) Connect four 25 watt lamps in parallel. (b) Remove one lamp and holding a screw driver by the wooden handle put the metal end into the socket of the lamp, move it until the center metal is connected by the screw driver to the outside metal. A *short circuit* then results. (c) Put in another fuse wire. Replace the small lamps by the four 100 watt lamps. This illustrates *overloading* the circuit. (d) Use 10 ampere fuse wire and connect the four 100 watt lamps.

Observations: What about the ability of fuse wire to carry current? Compare the 3 ampere and the 10 ampere fuse wire. Which is larger? What difference in capacity results from this difference in size? How is danger from electricity removed by fuses?

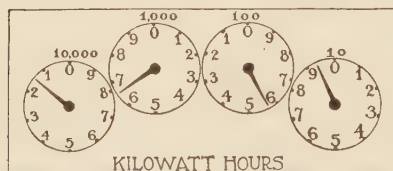
Applications: What are the dangers in the home from our electric current? When a fuse is blown how will you get the lamps to light again?

Fuses. — If we were to take a number of different metals and expose them to heat, we would find that some of them melt at a much lower temperature than others. Lead, for example, melts very readily. If you have seen the plumber solder pipes, you have noticed that he has a copper instrument which is used to melt the solder, so you know that red hot copper can melt solder. Low melting metals are used in making *fuse wires* and when placed in a house circuit are known as *fuses*. If a short circuit is produced, the fuse instantly melts, the electricity is cut off from the house, and thus danger from fire is prevented. If



we have electric lights in our home, we should know the location of the fuse box, and understand how to put in the fuse plugs in case they burn out. Of course, we must take care to *turn back the switch* first, thus cutting off all the electricity from the house, before we attempt to do this.

Measuring electricity. — Everybody should learn to read the dials on the ordinary electric meter, which is part of the equipment of every house that takes its electricity from the city supply. The meter is called the *wattmeter*, and the readings are made in *kilowatt hours*. The *watt* is the unit by which we measure electrical energy. One thousand watts make one *kilowatt* and one kilowatt used for one hour equals one *kilowatt hour*. A study of the diagram shows that of the four dials, the one to the left moves the least, while the one to the right moves the fastest. The four dials indicate thousands, hundreds, tens, and units. If the thousands hand is between 1 and 2, it will indicate 1000; if the hundreds hand is between 6 and



Wattmeter dials.

7, it indicates 600; if the tens hand is between 5 and 6, that will be 50, and the units hand, between 9 and 0, is read 9, making a total of 1659 kilowatt hours.

If the previous reading was 1610, then 49 *kilowatt hours* have been used since the meter was last read. At the rate of twelve cents per kilowatt hour what would the bill be? If your home is equipped with electricity, you will be interested to compare the bills rendered by the supply company with your own readings of the wattmeter.

SCORE CARD

215

SCORE CARD. DEVICES FOR CONVENIENCE AND LABOR SAVING IN MY HOME

	SCORE	
	Perfect Score	My Score
Electric fixtures		
Doorbells	2	
Telephone	5	
Vacuum cleaner	3	
Adjustable fixtures for reading	2	
Electric iron	1	
Electric cooker or heater	1	
Other devices (name them)	1	
Cleaning helps		
Carpet sweeper	2	
Dustless mop and dusters	1	
Washing machine or vacuum suction washer	2	
Clothes wringer	1	
Gas iron	1	
Wall ironing board	1	
Other devices (name them)	2	
Kitchen helps		
Fireless cooker	2	
Gas, electric, or blue flame stove	3	
Dishwashing machine	$\frac{1}{2}$	
Dish drying rack	$\frac{1}{2}$	
Bread mixer	$\frac{1}{2}$	
Meat chopper	$\frac{1}{2}$	
Egg beater	$\frac{1}{2}$	
Steam cooker	$\frac{1}{2}$	
Ice cream freezer	$\frac{1}{2}$	
Knife sharpener	$\frac{1}{2}$	
Other devices (name them)	1	
Other helps		
Sewing machine	5	
Electric motor or water motor for machine	3	
Other devices (name them)	2	
Tools and workroom		
Tool box and full set of tools	3	
Carpenter's bench	1	
Proper workroom	1	
TOTAL	50	

REFERENCE BOOKS

- Bachman, *Great Inventors and Their Inventions* (Edison). American Book Company.
- Baker, *Boys' Second Book of Inventions*. McClure Phillips Company.
- Barber, *General Science*, Chapter X. Henry Holt and Company.
- Book of Knowledge, *Articles on Electricity*. Grolier Society.
- Butler, *Household Physics*. Whitcomb and Barrows.
- Caldwell and Eikenberry, *General Science*, Chapter XVII. Ginn and Company.
- Clark, *Introduction to Science*, Chapter XXIV. American Book Company.
- Clark, *The Care of a House*, Chapter XI (For teachers). The Macmillan Company.
- Collins, *The Book of Electricity* (Wiring project). D. Appleton and Company.
- Croft, *Wiring for Light and Power* (For teachers). McGraw Hill Book Company.
- Fall, *Science for Beginners*, Chapters XXX, XXXI, XXXII. World Book Company.
- Hessler, *The First Year of Science*, Chapter VIII. Benj. H. Sanborn Company.
- Hodgdon, *Elementary General Science*, Chapter XI. Hinds, Hayden, and Eldridge.
- Jameson, *The Compass, the Signpost of the World*. Taylor Instrument Company, Rochester, N. Y.
- Knox, *All About Electricity*. Funk and Wagnalls.
- Lynde, *Physics of the Household*, Chapters XIX, XX, XXI. The Macmillan Company.
- Morgan, *The Boy Electrician* (For projects). Allyn and Bacon.
- New International Encyclopedia*, for lives of great discoverers of electricity. Dodd, Mead, and Company.
- Romance of Modern Electricity*. J. B. Lippincott Company.
- Shaefer, *Everyday Electricity*. Harper and Brothers.
- Tappan, *Wonders of Science*, "Interviews with Edison." Houghton Mifflin Company.
- Woodhull, *Electricity and its Everyday Use* (For projects). Doubleday, Page and Company.

PART VI. RECREATION

CHAPTER XV

RECREATION AT HOME

Problems. — 1. *To learn the nature of sound and the relation of our voice and ears to sound.*

2. *To learn the simple principles underlying music and musical instruments.*

3. *To see how to get the most home enjoyment from books, stories, and games.*

4. *To learn some ways to have fun with mechanical and electrical toys.*

5. *To learn what games can be played in the home yard.*

6. *To find out what science principles underlie our common games and toys.*

7. *To see how a lens makes objects appear larger.*

8. *To understand how pictures are taken.*

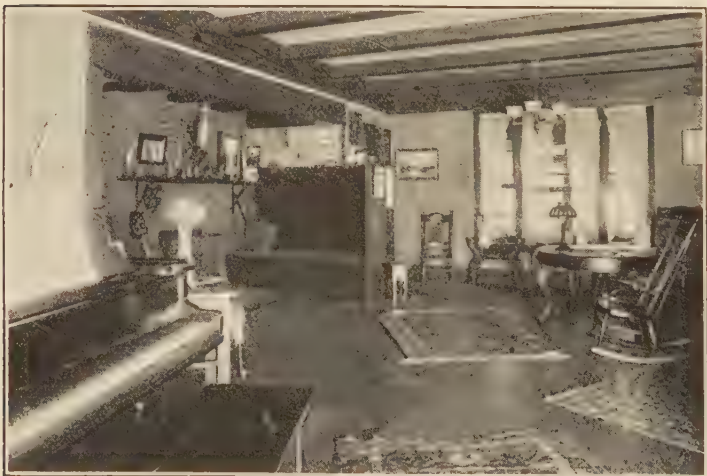
9. *To learn the relation of the earth to other heavenly bodies.*

Suggested projects. — 28. *To understand the mechanism of the piano and the piano player.*

29. *To plan for utilizing the playground of the home lot.*

The place of recreation in our lives. — The world of today pays far more attention to play than did the world of yesterday, for it has been found that recreation is an

important part of our lives. Recreation should mean *re-creation*, or adding new vigor to the lives of boys and of girls, as well as of adults. In order to get the most out of life, as all of us want to do, we should plan for our play hours almost as carefully as for our working hours—and learn to enjoy those things which are uplifting and helpful rather than degrading and harmful. In choosing



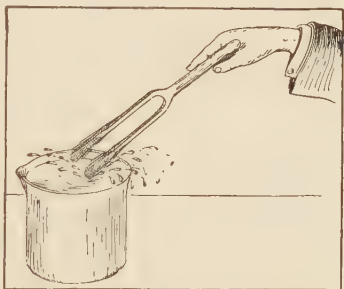
The home offers us a variety of activities which help in the best development of body and mind.

our companions, let us remember that we do not have to go away from home to find those who are best. An evening at home with something interesting to do or to play is a hundred times better than the “movies” or the street, and should bring the family together. Nothing can take the place of home, and the memory of pleasant evenings spent before the open fireplace, playing games, or reading good books, should be the heritage of every boy and girl.

Sound in relation to our home life. — Have you ever stopped to think what home life would be without sound? No mother's voice, no words from father, no conversation at the table, no music, either vocal or instrumental, and none of the hundreds of interesting events which depend upon the voice, for *without sound* means also *without voice*.

Experiment. — To see what causes sound waves.

What is sound? — When the alarm clock goes off in the morning, it makes no difference what part of the room it is in, we hear the bell, for sound waves travel from it in all directions. If we strike the prongs of a tuning fork on a block of wood, we hear the sound. If we strike the prongs again, and lower them into a vessel of water, we see a fine spray of water thrown from the surface. This is because the fork is

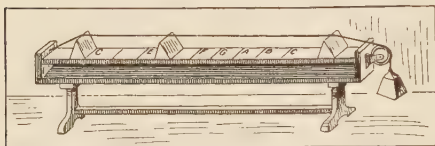


How to show that a sounding tuning fork is in motion.

in rapid motion, actually vibrating several hundred times a second. Just as waves move on the surface of water when we drop a stone into it, becoming wider and wider as they move farther away from their source, so a body that produces sound, as the tuning fork, sends waves off in all directions into the air. These waves fall upon the ear and produce the sensation which we call sound.

Our voice. — A study of the figure on page 220 will give us some idea of the appearance of our vocal cords, the organs used in the production of our voice. They are composed of two thin bands stretching from front to back across the voice box, which lies near the top of the

larynx. By means of muscles the tension of these cords may be changed and the size of the opening between them may be made larger or smaller. In deep breathing they lie flat against the side walls of the larynx, to allow a full



The pitch of a string is raised by shortening the wire and by increasing the tension on it.

entrance of air. But when we make a sound they come close together so that only a narrow opening is left between them. The

tightly drawn cords are set into vibration by the passing air, and thus sound waves result.

Demonstration Experiment. — Find out the relation of pitch to length, thickness, and tension of wires.

Materials: A sonometer. Wires of different diameters.

Method and results: (a) Pluck a string on the sonometer. Put a bridge under the middle of the string dividing the string into shorter



Vocal cords.

lengths. Pluck one of these holding it firm on the bridge. What effect does shortening the string have on its pitch?

(b) Compare the sound of two wires of the same length and tension but of different diameters. Which gives the higher pitch?

(c) After plucking one string increase the tension on it and pluck it again. What effect does increasing the tension have on the pitch?

Conclusion: How is the pitch of a sounding wire dependent upon length, thickness, and tension?

Application: Why are the wires in a piano of different thicknesses and of different lengths? Why does a piano need to be "tuned"? How is it done?

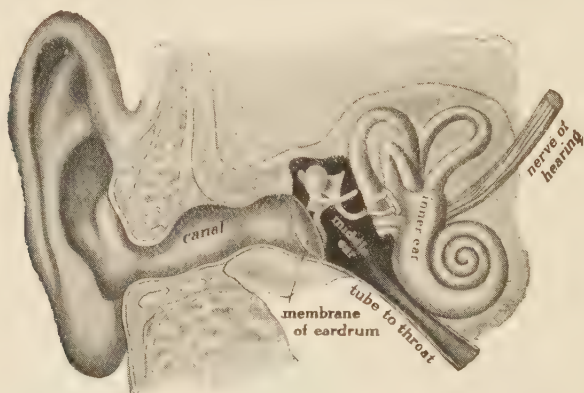
Differences in the pitch of the voice. — A child's voice is shrill or high pitched because its larynx is narrow and the vocal cords are short. In the demonstration experiment given above it was shown that long wires or strings, when vibrating, give a much lower and deeper tone than do short strings. When a boy's voice is breaking or changing there has been a sudden growth of the larynx, and in consequence, a lengthening of the vocal cords.

How we talk. — When we speak in a monotone, all of our words are of the same pitch, and yet we can distinguish differences in the sound of the different words. This is due to the quality of the sound waves. As these waves pass through the mouth they are changed in quality by movements of the tongue, soft palate, cheeks, jaws, and lips. Watching yourself before a mirror while you say *a*, *e*, *i*, *o*, and *u*, will show you that in each of these sounds, a different position of the parts of the mouth and throat is assumed. Get the habit of clear enunciation while you are in school, and it will be a help to you through life.

How we hear. — Sound and speech would not be of much use to us if we could not hear. The outer ear, which is simply an organ to help gather the sound waves, leads by means of a tube into the middle ear and is separated from it by a delicate membrane, somewhat like that on a drum head. In the middle ear are three tiny bones which serve as a bridge to carry the sound waves from the membrane to the inner ear. Here deep in a space in the bones of the skull is an instrument a thousand times more delicate than the most wonderful piano in existence. This instrument

receives the sound waves and transfers them by means of a nerve to the brain. The inner ear is a balancing organ also, and in many lower animals has apparently no other function. We get our sense of equilibrium by means of three semi-circular canals which lie in the bone in three different planes.

Music and noise. — Harmony in pitch relations and in the periodic movement of sound waves causes us to think

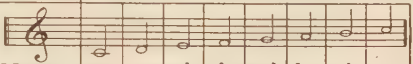


Parts of the ear. Notice the three bones in the middle ear.

of sound as music, and discordant vibrations as noise. The beating of a tom-tom and the monotonous chant of a savage in his war dance are periodic, and have a definite pitch, but they are not pleasing to our ear, hence they cannot be classified as music to us.

The musical scale. — Our music is built up on a series of sounds having definite ratios of vibration. A study of the diagram on page 223 shows the staff, with the names of the notes or the letters given these notes, and the number of vibrations each makes. This series of tones, which is used for all kinds of musical instruments, is known

as the musical scale. Each higher tone in the next octave will have twice the vibration rate of that of the corresponding letter in the octave shown in the diagram, and each of the next lower octave will have half the vibration rate of the corresponding tone in the octave shown. There are on the keyboard of the piano and organ black keys which have intermediate rates of vibration.



Name	do	re	mi	fa	sol	la	ti	do
Letter	C	D	E	F	G	A	B	C
Number of Vibrations per second beginning with middle C (piano)	258.7	290.3	325.3	345.3	387.6	435	488.3	517.4
Standard of the Physicist	256	288	320	341 $\frac{1}{3}$	384	426 $\frac{2}{3}$	480	512

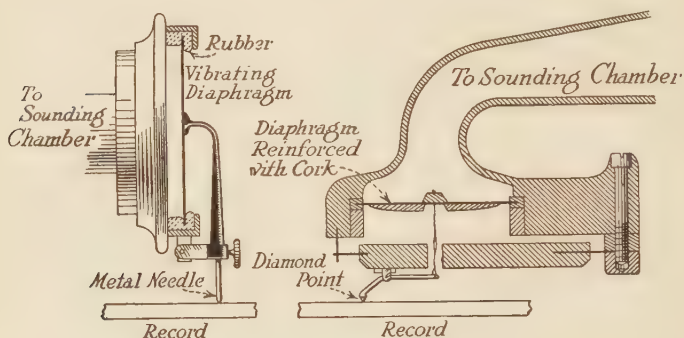
The musical scale.

These are the so-called sharps and flats, without which modern music would be impossible.

Stringed instruments and how they make sound. — In stringed instruments, such as the banjo, guitar, mandolin, violin, and cello, the musical scale is made by shortening the strings with the fingers. In the piano and harp, the strings are all of varying lengths, each producing its own tone. Just as we found that by changing the shape of the mouth and tongue we could produce different qualities of tone, so the instrument maker produces different qualities by making his instruments in different shapes.

The phonograph. — The phonograph, a device for reproducing sounds, has become a very important part of our home life, for though relatively few of us are capable of producing music, most of us enjoy it. The original sounds of those which are later reproduced in the phonograph are recorded as a fine wavy line on a wax cylinder or plate. The records we buy are duplicates of this original,

or *master record*. The reproducing mechanism has a diaphragm capable of very delicate vibrations connected with a needle which rests on the record. When the record is set in motion, the needle follows the fine wavy line and is



made to vibrate in correspondence with the vibrations of the original sound waves. These vibrations are communicated to the diaphragm, which causes sound waves in the air that come to us as reproductions of the original sound.

Good reading and what it means. — We have already said that life is made up of bundles of habits. Habits are formed by doing things over and over again and you are now at an age when you can form them most easily. Why not use some of the time you spend in recreation in getting the habit of reading good books and good magazines? Far too many boys and girls limit their reading to the daily newspaper and some of the various cheap weekly and monthly magazines. Life will be far richer to you if instead of feeding your mind upon trash, you give it something which will be of use to you later. It is largely a matter of habit whether you read poorly written stories

with nothing of real value in them, or whether you read books that are worth while. The librarian in your school or in the public library will furnish you with a list of books that other boys and girls have enjoyed and that are worth reading. Develop the habit of reading good literature and read all you can.

Our relation to the home. — Have you ever thought that the whole of society as we know it in this country and in all the civilized world is built around the family as a center? We are not individuals living alone. Every act of ours, whether selfish or not, is likely to influence some other person's life. We obey mother and father because we love them. For the same reason, let us not forget that they were young once and are probably interested in what we are doing and thinking.

Home amusements. — Perhaps playing games is one of the best ways of spending our recreation time in the evening. Checkers, dominoes, and halma are all good games which train us in an interesting kind of mental arithmetic and to think quickly. Crokinole, carroms, and table tennis or games in which marbles are used, are games of skill in which the eye and the hand are trained. Chess requires so much skill that many volumes have been written on how to play it, and it has been called the royal game. Another interest which may be developed in the home is stamp collecting. Not only is it good fun to have a collection of stamps, but also in this connection we learn a great deal about the geography, money, and even the peoples of the world. One can make a stamp album out of a cheap blank book. A stamp catalog will be of great assistance in placing the stamps where they belong.

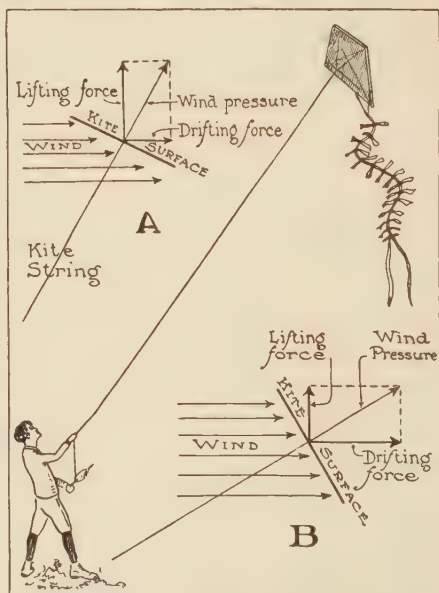
Toys which illustrate some physical principles. — Tops, darts, arrows, kites and sailboats, all illustrate certain physical principles which every boy and girl ought to know about. For example, we have all heard of the gyroscope, an instrument used to prevent ships and airplanes from overturning in storms. The top while spinning illustrates what is known as *gyroscopic motion*.



The gyroscope.

The *elasticity* of wood and cord is shown in the use of the bow and arrow. A sling is whirled round and round before releasing the missile, thus giving a good example of *centrifugal force*.

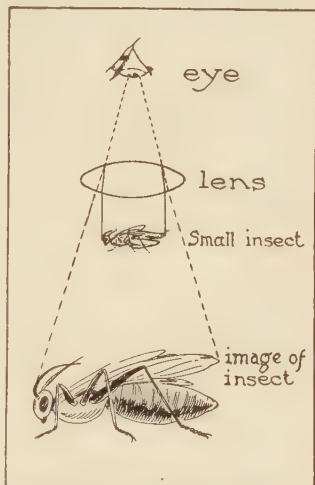
In flying a kite we use the force of moving air, and by fastening it at an angle to the direction of the wind, we cause it to rise higher in the air.



Notice that the wind produces a greater lifting force in A than in B, but that in B the greater part of the force of the wind causes horizontal drifting. This results from the angular adjustment of the kite surface.

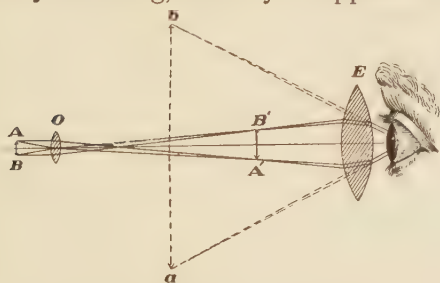
Mechanical and electrical toys. — Not all of us can afford the expensive mechanical toys made as railroad

trains, boats, submarines, and airplanes that we see nowadays, but almost anyone can learn, with a few simple tools, to make a small imitation of some of the mechanical devices that make the lives of grown-ups so interesting to-day. Model airplanes, engines or boats give us opportunities to try out our skill in lines that may lead to our future life work. Electricity is a powerful servant and a little knowledge of it applied to the making of an electric motor or to a wireless telephone or telegraph outfit, will result in hours of pleasure and profit.



A simple microscope.

The microscope. — If you look through a double convex lens on a small object such as a fly or a bug, the object appears larger than it really is.

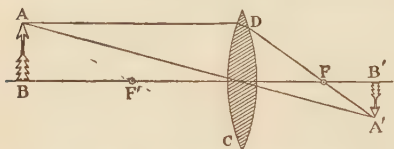


The compound microscope makes an image $A' B'$ nearer the eye than the object AB and then magnifies it to a still larger image ab .

double magnification, first, by a glass near the object, or the *objective*, and later by a glass near the eye, or the ocu-

The reading glass is a simple microscope consisting of a double convex lens. The compound microscope, as the diagram shows, has two sets of lenses, which make the object look larger by a

lar. Thousands of wonderful objects lie unseen at our doors, and can only be discovered by means of this wonderful instrument. Perhaps some day, when you study



How a lens makes an inverted image.

biology, you will learn more about the microscope and its uses.

Lenses and their uses. — If we study the figure we find that

when a ray of light passes through a lens at one side of the center, it is refracted or bent out of the straight line AD to take the course DA' , while when it passes through the center it continues on its course in a straight line. This causes the point A of the arrow AB (the object) to become A' on the arrow $A'B'$ (the image). Those of you who have cameras know that the image seen on the ground glass of the camera is inverted. The illustration helps us to understand this fact. Most cheap cameras have a single lens. A lens tube has a double combination of glasses in it which may be of long focus. There is a wide angle lens of short focus also, which is adapted for interior views. We have the telephoto lens, which is used for long distance work, and is excellent for photographing birds, and other forms of wild life.

Photography. — Probably one of the most fascinating hobbies that any boy or girl can have is that of photography. Not only does it help us to understand the practical use of the camera and its accessories, but it assists us in seeing the artistic value of objects also. The accompanying pictures of a farmhouse illustrate very well what is meant by composition and balance. A close view (No. 1) shows the house without grounds or shrubbery.

It is an example of poor composition although it has good balance of strong light and dark objects. The second is a better picture than the first. The house at the left is balanced by the road leading to the right, but as no particular object of interest is shown at the right the picture has poor composition. In the third picture the garden path with its border of shrubs and flowers leads you unconsciously right to the door of the house. There is a balance of strong light and strong dark with intermediate tones as well. By making a study of photographs you can learn easily what it is that gives them artistic value.



1. Picture of a bare house.



2. The same house with a setting of grounds and foliage.



3. The same house from another viewpoint. A charming picture.

What is a negative? — The picture is taken upon a glass plate or celluloid film covered with a coating of gelatine and silver bromide, or some other silver salt. Light falling

on this compound causes a change in its composition, so that when it is put into a developer containing certain chemicals which complete the change and make it permanent, a *negative* results. This negative gives the light



Which of these two pictures is the *negative*? Which the *positive*?

values in black and white, but the opposite of what they were in the objects photographed and the opposite of a *positive*, or completed print. A study of the accompanying figure will show this very clearly.

Experiment. — To show the processes of printing, developing, and fixing a picture.

How to take a photograph. — In taking a picture, we should bear in mind the following points: (1) Try to get

good balance and a pleasing composition in your picture.

(2) Focus on the principal thing to be photographed. (3)

Have good light, and if possible, have the light come from behind the camera. Do not have the sun shining directly into the lens of the camera. Do not have much light and shadow, except in landscapes. (4) Be sure that the opening in your lens is the right size for the amount of light.

This is easily determined by a study of the directions that come with the camera. Experience will teach you how to use your own lens after working with it for a time.

(5) Be sure that you use an unexposed plate or film.

Many pictures are spoiled by double exposures. The best way is to write on your plate holder or film each time you take a picture. (6) Be sure to make the exposure of the proper length. Too long an exposure is as bad as too

short an exposure. (7) The camera must not be allowed to move, even in an instantaneous exposure. (8) If

you take a snapshot be sure that the image of the object you wish to take is in the finder when you snap the shutter.

Printing. — Boys and girls should learn to print their own pictures rather than send them to a photographer, for it is easy, and a fascinating pastime. Papers are of two types, those printed by artificial light and those printed by sunlight; the latter require more time and a dark room. Blue print paper is one form of sun printing paper, and is cheap and easy to handle, since it can be printed from a negative, and washed in cold water.

Enlarging. — If you have a particularly good picture, you may wish to enlarge it. This can be done by making a positive image or picture with rays of light passed through a negative, and then through a lens which is

focused on a sheet of sensitive bromide paper. The size of the enlargement will depend on the distance of the lens from the sheet.

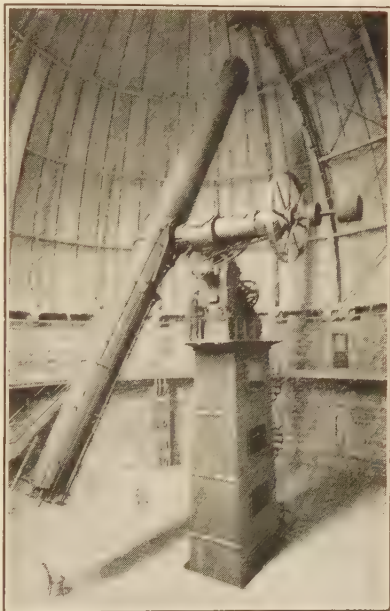
Other uses of lenses. — We are all familiar with the use of opera glasses and field glasses. A good pair of field glasses decreases the apparent distance of the object looked at to one eighth of the real distance. A four-inch telescope may make an object appear 300 times nearer. In the telescope, one lens is used to make an image of the distant object, and the second lens, or the eyepiece, is used as a simple microscope to magnify this image. An evening with the telescope is an experience that few boys and girls will forget. An acquaintance begun early in life with a few heavenly bodies may become a recreation that will give you much satisfaction throughout your later years.

The stars. — Even without a telescope, the heavens present a wonderful opportunity for observation to those who are interested in the distant parts of the universe. A glance at the sky makes one think he can see myriads of stars, but in reality one can rarely see more than from two to three thousand stars on an average, while standing in one place, but by the use of a large telescope, millions of stars are found. Astronomers tell us that some of these stars are like our sun, in being a huge, white-hot ball, and that many of them are very much larger. They all appear very tiny because of their great distance. When we realize that the nearest of these stars (Alpha Centauri) is 25,000,000,000,000 miles away, so far that it takes about four and one third years for its light to reach us, we cannot but be amazed. And when we know also that another star (Arcturus) is 950,000,000,000,000 miles away,

and that it takes one hundred sixty years for its light to reach us, we are lost in wonderment. It will help you to get some idea of the velocity of light when you think that as you have taken five steps across an ordinary room, light has traveled a distance equal to about twenty times the circumference of the earth.

Our relation to the stars. — You have obtained in your geography some knowledge of the relation of the earth to the other heavenly bodies. You remember that there are eight planets which travel around the sun, the earth being one of them. They do not give out light of their own, but reflect sunlight, and appear as brilliant stars, visible only in the morning and the evening, and therefore called morning stars and evening

stars. As we have just learned, they are not true stars, because they do not shine by their own light. The names of the planets, in order according to their nearness to the sun, and the length of their year (or the time to go around the sun), are shown in the following table:



Yerkes telescope of University of Chicago, one of the largest in the United States.

Mercury	88 days	Jupiter	12 years
Venus	225 "	Saturn	29 "
Earth	365 "	Uranus	84 "
Mars	687 "	Neptune	165 "

Some of these planets, such as the Earth, Jupiter, and Mars, have moons which in turn revolve around them. These reflect sunlight only, and do not give any light themselves. All of these moons, planets, and the sun together make up a small heavenly group called the *Solar System*. You may think the word *small* used inadvisedly. It is a large system when compared with the size of the earth, but compared with the size of other systems and the vast expanse of the universe which we look into on a clear night, it is absolutely insignificant. It is reasonable to believe that each of the millions of stars in the sky has its own family of planets and moons, just as our sun has, but

since these are so far away and have no light of their own, they are invisible to us.

The sun. — The diagram shown here gives the size of the sun compared with the planets. It has, for example, about 12,000 times the area of the earth.



Relative sizes of planets, sun, and moon.

Its size makes it hold by the attraction of gravitation the planet Neptune, which is 60 times as large as the earth, and about 2,780,-

ooo,ooo miles away. The sun is a source of power in more ways than this, for does not its heat make life possible on the earth? Have you ever thought how the sun's energy is directly responsible for plant life without which animals could not live?

Our neighbor the moon. — If you can get the use of a good field glass or small telescope, look through it at the moon and study its different phases. You will find it a most interesting object for observation. Did you know, for example, that the larger markings are probably rugged mountain chains full of wide craters and deep valleys running for hundreds of miles in different directions?



A portion of the moon's surface seen through a telescope. Notice the craters of extinct volcanoes.

Do you realize that the moon has no atmosphere and that life, if it exists at all, must be very different there from our life here?

The earth is almost twice as dense as the moon and as a result a person could lift almost six times as much there as he could on the earth. Had you thought that, in spite of its being about $\frac{1}{4}$ the diameter of the earth and an average distance of nearly 239,000 miles away, its attraction, as it revolves around the earth, is the chief cause of the tides?

Eclipses and their cause. — Most of us have seen an

eclipse of the moon but few of us an eclipse of the sun. An eclipse of the moon is caused by the earth coming between the sun and the moon, thus shutting off the sun's light from the moon's surface and causing it to appear

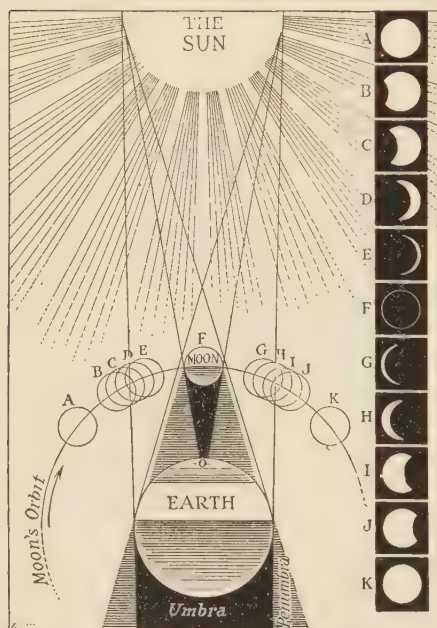


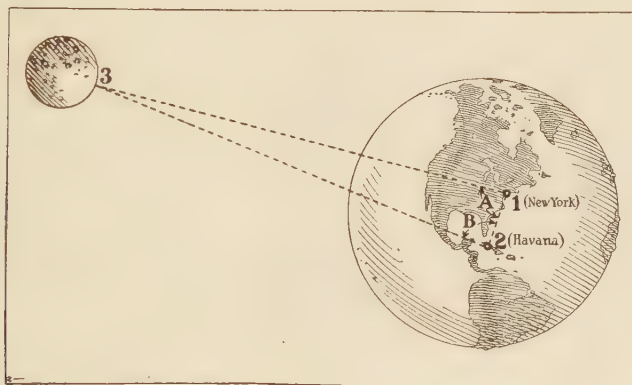
Diagram to explain an eclipse of the sun.

dark. The eclipse of the sun is caused by the moon coming between it and the earth. Since the moon is so much smaller than the sun the latter appears covered only at a narrow belt on the earth's surface. At some other points on the earth's surface the eclipse is partial, i.e. the moon's shadow does not cover the sun completely. Eclipses can be foretold with great accuracy and

if it is your good fortune to be located where an eclipse of the sun is visible, you should prepare a piece of deeply smoked glass and have it ready so that you can look at the sun through it and observe the moon's shadow creep over the face of the sun.

How distance to planets is measured. — The method of measuring distances to other planets is based on what the mathematician calls triangulation. That is, two points

some distance apart are selected and from them careful observations are made of a given planet at a certain moment. The angles between these points and the planet



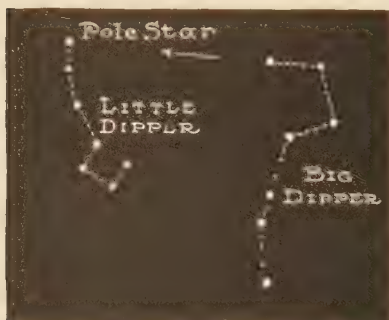
Method of measuring distance to another planet.

being measured, it is possible with a knowledge of trigonometry to calculate the distance to the object.

The North Star.—A star which has guided many travelers is the North Polar Star (Polaris). When we look at it, let us remember that the light which enters our eyes left that star about forty-seven years ago. Since this star is practically in line with the axis of the earth, and all other stars keep the same relative positions, with respect to it, there is during the rotation of the earth each twenty-four hours an apparent rotation of all of the other stars in the sky about the North Star as a center. This fact makes it of exceptional value to the traveler.

The Big Dipper.—One of the most conspicuous star groups or constellations is the Big Dipper, or Great Bear, as it is sometimes called. If you are learning some of

the more prominent stars and star groups, the Big Dipper is one you should locate first. From that you can find the North Star (Polaris) and then work out to other groups. If you examine the diagram, you find that a line



Which two stars are the "Pointers"?

drawn through the two stars at the end of the Big Dipper points directly toward Polaris, hence they are called the "Pointers."

Other star groups.

— Polaris is the end star in the handle of the Little Dipper, or Small Bear, which can

be found easily. Except in the region near the North Star, some stars will be visible at certain hours of the night and invisible at others. It is an excellent plan to get some older person to show you how to use a star map, and then try to see how many new constellations you can identify. The "Guide to Nature" and the "Scientific American" have a star map each month, which tells you the time of evening to look for certain constellations.

Shooting stars. — It is not strange that some people have been de-



A shooting star.

ceived by so-called "shooting stars" and thought that the stars were actually falling. Such, however, is not the case. There are, throughout the space that surrounds the

earth and other planets, countless numbers of small bodies which are moving at a speed almost one hundred times as swift as that of a rifle bullet, but since there is no air, there is no resistance to these bodies, and they cannot be seen. If any of them going at this rate of speed reach the upper air, they become hot because of the friction and begin to glow so that they appear as objects which are on fire. Since the earth attracts them, they fall toward it, usually reaching it as dust. Sometimes, however, a very large meteor plunges into the earth, and when we dig it up, we find it to be a mass of rock looking not unlike iron.

Home and community. — All through this section of the book we have tried to show how science touches our everyday life. Only a few of the many home pleasures have been suggested here, for much of your pleasure will be had in the companionship of others. Hiking, fishing, camping, boating, and bathing are all pleasures that others must share with you to be really fun. Therefore we leave the discussion of these to your project making and to the later treatment of community life. It is hoped that the section you are just finishing will help to make you better and more useful members of your own family. The purpose of the next section will be to show you how intimately science is connected with the lives of those who live together as citizens in the community and to help make you more useful and efficient citizens.

My final home score. — After you have finished this card you are to take all of the completed cards and copy in the column marked "My final real score" in the long preliminary score card, the totals for each of the smaller cards at the ends of certain of the chapters. It will be interesting to compare your final score with the guess you made at

the beginning. Were you too high in your first estimate? And do you really think you have improved conditions somewhat as a result of this study of science? If so, then this part of the book will have accomplished its purpose.

SCORE CARD OF OUTDOOR RECREATIONS (FOR GIRLS)

	SCORE	
	Perfect Score	My Score
Have set up (5) and can play <i>well</i> (5) one of the games mentioned on page 28	10	
Can play <i>well</i> tennis, croquet, or beanbags	5	
Collect flowers and can identify at least 20 species or varieties	10	
Collect insects and have specimens of at least six orders . . .	5	
Make photographs (5), develop and print my own pictures (5)	10	
Belong to Hiking Club or Girl Scouts — can walk at least ten miles in a day without feeling tired	5	
Can pick out North Star and identify at least three constellations	5	
TOTAL	50	

SCORE CARD OF OUTDOOR RECREATIONS (FOR BOYS)

	SCORE	
	Perfect Score	My Score
Have set up (5) and can play <i>well</i> (5) at least one game mentioned on page 28	10	
Have made a kite that will fly and stay up in a moderate wind <i>or</i>		
Have made a model airplane that will fly at least 100 feet	10	
Have made a sailboat that will sail against the wind . . .	5	
Collect insects and have specimens of at least six orders . . .	5	
Make photographs (5), develop and print my own pictures (5)	10	
Belong to Hiking Club or Boy Scouts, can walk at least twenty miles a day without feeling tired	5	
Can pick out North Star and identify at least three constellations	5	
TOTAL	50	

SCORE CARD OF MY INDOOR RECREATIONS

	SCORE	
	Perfect Score	My Score
Piano or organ	5	
Playing or singing by members of the family	5	
Victrola or piano player	5	
Have read at least five standard books	5	
Habitually read at least three standard magazines	5	
Talk over day's experiences and tell funny stories at meals	5	
Group games played, whole family taking part sometimes	5	
Skillful in at least two games mentioned in Chapter XV	5	
Collect stamps or other objects; have a hobby	5	
Have made at least one toy, mentioned in Chapter XV, or have completely dressed a doll, making all clothes myself	5	
TOTAL	50	

REFERENCE BOOKS

- Adams, *Harper's Outdoor Handy Book*, pages 120-143 (Kites). Harper and Brothers.
- Baker, *Boy's First and Second Books of Inventions*. McClure, Phillips, and Company.
- Ball, *Starland* (Last chapter, although entire book is interesting reading). Ginn and Company.
- Beard, *American Boy's Handy Book* (For projects). Charles Scribner's Sons
- Beard, *Outdoor Handy Book*, pages 46-94 (Kites). Charles Scribner's Sons.
- Beard, *What a Girl Can Make and Do* (For projects), pages 227-235. Charles Scribner's Sons.
- Bedell, *Practical Electroplating* (For projects). Published by author, Springfield, Mass.
- Bodmer, *Book of Wonders*. Project references. Presbrey Syndicate
- Book of Knowledge*, Project References for all above.
- Brownell, *General Science*, Chapter X. P. Blakiston's Son and Company
- Butler, *Household Physics*, Chapter IV (Sound). Whitcomb and Barrows.
- Campbell, *American Girl's Home Book of Work and Play*, pages 175-183 (Archery) G. P. Putnam and Sons.
- Carrington, *The Boy's Book of Magic*. Dodd, Mead and Company.
- Cassell, *Complete Book of Sports and Pastimes*, pages 239-244. Cassell and Company.
- Chemistry Sets, Electrical Sets, Erector Sets*. A. C. Gilbert Company, New Haven, Connecticut.
- Chemistry Sets, Chemcraft*. Porter Chemical Company, Hagerstown, Maryland.
- Downing, *A Field and Laboratory Guide in Physical Nature-Study*. University of Chicago Press.

Fisher and Fisk, *How to Live*, Chapter IV (For teachers).

Hall, *Home Made Toys for Girls and Boys*. Lothrop, Lee and Shepard Company.

How to Make Good Pictures. Eastman Kodak Company, Rochester, N. Y.

Kelley, *Three Hundred Things a Bright Girl Can Do*. Dana Estes and Company.

Lynde, *Physics of the Household*, Chapter XXVIII, XXIX. The Macmillan Company.

Meccano Outfits. Meccano Company, Inc., New York.

Miller, *Outdoor Sports*. Doubleday, Page and Company.

Miller, *Outdoor Work*. Doubleday, Page and Company.

Sloane, *Electric Toymaking for Amateurs* (For home projects). Norman Henlev, and Company.

Smith and Jewett, *Introduction to Science*. The Macmillan Company.

Thompson, *Boy's Book of Sports*, pages 177-196. The Century Company.

Tolman, *Hygiene for the Worker*, Chapter X. American Book Company.

Williams, *How it Works*, pages 227-309. Nelson and Company.

Winslow, *Healthy Living*, Chapter XVI. C. E. Merrill and Company.

SECTION II. COMMUNITY SCIENCE

PART VII. ADVANTAGES OFFERED BY THE COMMUNITY

CHAPTER XVI

THE IDEAL COMMUNITY

Problems. — 1. *To find out what factors of my environment are important for the good of the community.*

2. *To see what natural advantages my home community has.*

3. *To find out what man has added to nature to make my community a good place in which to live.*

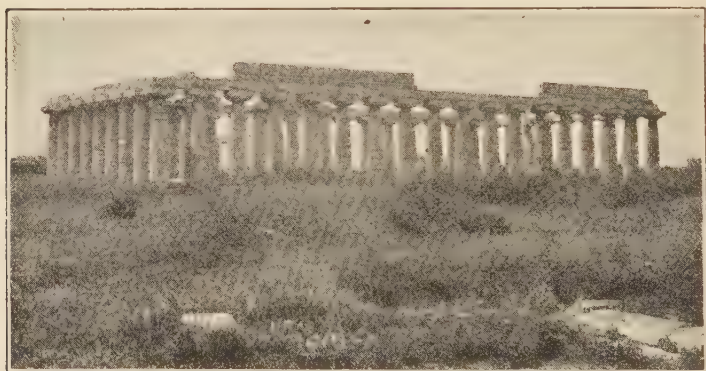
4. *To learn how I can help make my community a better place in which to live.*

5. *To understand the need of wise laws and regulations in the community.*

Suggested project. — 30. A study of the advantages and disadvantages of my community.

What is most important for a community? — Of all the important things that make a community a good place in which to live healthfulness stands at the head of the list. Many a city of ancient Greece, once adorned with beautiful buildings and charming surroundings, and important commercially, had its inhabitants bitten to death by the malarial mosquito. Many cities of South and Central

America, as well as of our southern states, were very unfavorable places to live in before it was discovered how to combat the dread yellow fever. Location, favorable opportunities for trade, good government — all would mean little to the inhabitants of a community without good health to enjoy them, and good health depends upon the coöperation of every one in the community as well as the care that those placed in control exercise. As one writer



Only ruins mark the place where the thickly populated Greek city of Paestum once existed in southern Italy. Blocking of the mouth of Silarus with silt caused overflowing of the banks and the resulting marshes became the homes of countless malarial mosquitoes.

has expressed it: "Health is a civic obligation." Perhaps the best indication of the health of a city is the physical condition of its school children. Where this is satisfactory it shows that not only the community is trying to take care of its young citizens but that they in turn are trying to do their share toward promoting good health in their town.

The factors of environment. — We have found that living things, in order to exist, must have air, heat, light, water, food, and soil. Each of these factors plays an important

part in the life of every individual. They play an equally important part in the relation of one person to another in a community.

Air. — We are all familiar with the term “pure air,” but we do not realize always what it is. The boy or girl who lives in a big city where much soft coal is used does not breathe pure air. City air contains, besides dust and bacteria, a considerable quantity of carbon. Many fac-



How the air in one community was improved when a smoke consumer was installed in the furnace of a near-by factory.

tories and industrial plants produce noxious gases which make living near them unpleasant if not harmful.

Heat and temperature. — It is not mere chance that most people live in temperate climates, nor that a large part of the world's activity is found in the temperate zone. Climate plays an important part in life. Recent experiments have shown that the most efficient work can be done at a temperature which we call moderate; that is, between 60 and 70 degrees Fahrenheit. As a matter of fact, most great scientists and men and women prominent in the world of art, literature, or business, have made their name

in temperate climates. Our ideal community, then, should have a moderate temperature without great extremes.

Light. — Light is of great importance to health. We live in a temperate zone where light is abundant, and although our days are shorter in winter than in summer, we do not have, as the Eskimo does, a winter night several



Fine winter sport.

months in length. In addition, we have artificial lighting. One of the factors we must judge our community by is its lighting system. Is the system up-to-date? Is it sufficient for the needs of the community?

Weather. — Favorable weather conditions are important factors in our community life. There is an advantage in living near a body of water because it is warmed more slowly than an equal body of land and consequently, a breeze may come in from the water to the land at night.

This accounts for the cool evening breeze which so frequently makes life bearable in a hot city near a large body of water, as in Chicago or New York.

Another weather factor is the kind of wind which prevails. Very strong winds, especially tornadoes, have often wrought much damage to crops and buildings.

Because of the prevailing westerly winds, the rainfall on the western coast of the United States is much greater



Rainfall Map of the United States.

than it is farther inland. This is because the wind, loaded with moisture from the ocean, condenses as it rises to pass over a range of mountains, and gives up part of its moisture as rain. This explains, in part, the desert conditions in the southwestern section of the United States, for there the westerly winds pass over two or more mountain ranges and give up most of their moisture before they reach the interior. Local conditions, such as forests, wooded hills, small ponds, help to equalize climate and contribute to

rainfall also. Determine whether or not your community is located favorably as to rainfall. Give your reasons for your judgment. Snow would have to be considered in our ideal community life. It keeps the soil in good condition and in lumbering regions it is of great use, as the logs may be sledded out easily to places where they can be sawed into lumber. On the other hand too much snow hinders transportation on streets and railroads.

Are you a community helper? — An important purpose of this book is to show boys and girls what the essential factors are which make a community a good place in which to live, and to try to make them realize that they, as the future citizens of the community, must be awake to their opportunities and responsibilities. They should, when this year's work is over, be able to appreciate better their part as citizens in improving their environment.



New York Harbor from the lower end of the city.

Presence of water routes. — Navigable bodies of water are of very great importance also in determining the eco-

conomic standing of a community. Examples of cities which are well located are New York, with its great harbor at the mouth of a large navigable river; Boston and Rio Janeiro, each on a splendid harbor; Detroit, St. Louis, and New Orleans on large rivers; and Albany and Pittsburgh on rivers near the head of navigation. The problems of transportation and communication are of the utmost im-



Shipping along the water front.

portance to any large city, and many communities owe their prominence to the fact that they lie along lines of easy communication between two or more large terminal cities.

Water power. — Water power on a river is another factor in the determination of the location of a town or city. Frequently, in olden times, a mill to grind wheat or corn was placed near water power, and as the people of the neighborhood depended upon the products from this mill, a community would gradually develop around it.

Water power is still of great importance in running machines for factories and in producing electricity. Large manufacturing communities, such as are seen along the Merrimack River in Massachusetts, have developed where water power is available.



Water power in a manufacturing city.

Importance of soil. — The soil is of great importance in determining the healthfulness of a community. Farming communities are located usually in limestone regions or those having rich alluvial soil. If a city or town is built upon small hills composed of sand or containing gravel soil, drainage will be good and little standing water will be found. If, on the other hand, the town has considerable rock underneath it, clay or other impervious material, the drainage is not likely to be good and standing water will be found. If a city or town has marsh land adjacent to it, the mosquito problem may become very grave and its inhabitants be menaced by malaria or yellow fever.

Sewage. — Among the problems confronting each community in these days are those of providing some means for the disposition of liquid wastes in the form of sewage, and of solid wastes as garbage. Large cities have to spend much money in properly disposing of these wastes. Where towns have natural slopes and a body of water into which



The mosquito menace may be removed by draining and filling a swamp.

to drain the wastes, the disposal of sewage is a comparatively simple matter, but sometimes there are no natural slopes, no river or ocean to drain into, and the city must get rid of all its waste by means of a disposal plant.

Garbage. — Garbage disposal also is of very great importance for the health of the city. Garbage pails, if left

uncovered, are apt to become breeding places for flies, and flies are carriers of disease. We must always remember that coöperation on the part of everybody is necessary if our community is to be free from flies.

Housing. — In an ideal community, every family lives in a detached house with land for a little garden and a few trees. The house has ample ventilation. Bedrooms have two windows each and a sleeping porch is provided.



What are the advantages and disadvantages of these two types of homes?

Unfortunately these conditions do not prevail in a large city. Not only do we have rows upon rows of closely built houses with little or no space for gardens or playgrounds, but we have apartments or flats piled one on top of another. If such buildings must exist, it is of the utmost importance to the health of the inhabitants of that community that ample ventilation in the form of airshafts and windows be provided. The ideal community has laws regarding such ventilation and these laws are enforced. Has yours?

Public supplies. — When people live together there are

certain things which it is economical to control in common, as water supplies and milk supplies. An ideal community must have an abundant supply of pure water. Los Angeles has provided its inhabitants with over 200 gallons of water a day for each individual, and the new aqueduct of the city of New York brings over 150 gallons to each inhabitant daily. The source of the water must be free from con-



What three things were done for improvement around this public building?

tamination, so that pure water will be delivered to the city. If, as in some cases, it is impossible to get pure water, then the water must be made safe by filtering or treating with chlorine to kill any harmful germs which may be in it. Milk supplies, although sold by private concerns, should be under public supervision in every community. Milk is one of the most important factors to the health of the babies of a community, and upon the health of the babies depends the welfare of the future inhabitants of the town.

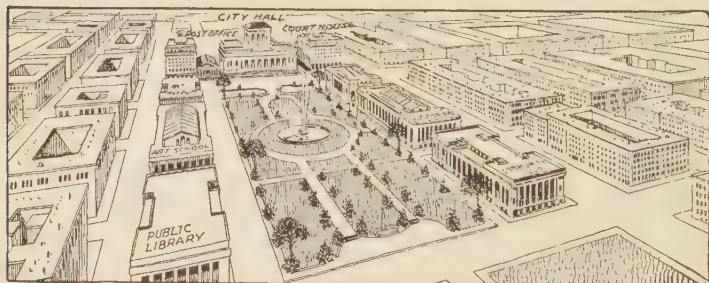
Community planning. — No city or town should be allowed to grow in a haphazard manner. It is essential that streets are wide enough for all traffic and planned for



Improving the environment by the removal of signs.

the future growth of the community. Parks should be scattered here and there, especially in the poorer sections, for people without home grounds need something to make up for this lack. Playgrounds, with bathing pools and bathhouses, should be numerous. Ugly

buildings, billboards, and unkempt vacant lots ought to be prohibited by law, and smoke, dust, and unnecessary



A well-planned group of community buildings, in which are shown a City Hall, Court House, Post Office, Art School and Museum, Auditorium, and Community Club.

noise reduced to a minimum. Lastly, churches, libraries, and schools, with a community auditorium and stadium

or outdoor theater, should be included in the plan of our ideal community.

Community government. — Laws are not of much value unless they are enforced. A community government should make wise laws which will keep its citizens safe and healthy, and then it should enforce these laws. A city, furthermore, must have several active departments which will provide for lighting the streets, taking care of the water supply, looking after health, protecting homes from the menace of fire, and keeping the streets well policed and its laws and ordinances from being violated. The work of the department of health is of particular importance because it not only sees to it that all public supplies, such as water and milk, are uncontaminated, but also it attends to the making and enforcing of laws for the supply of pure foods. It requires all cases of contagious diseases to be reported and attends to laws regarding quarantine. Epidemics should not be a part of modern life, for they occur usually through carelessness. Modern methods for the combating of disease should prevail. Hospitals and sanatoriums must be provided for various diseases, and at least one hospital, removed from the town, where tuberculosis patients have the best care.

Schools. — Fully as important as the department of health and perhaps more so are the schools, for a modern school in our ideal community should not only teach but should also take care of its children. Hygiene should be taught in schools, and school clinics provided to examine and care for the teeth and the eyes, the throats and the noses of the school children. In addition to this, boys and girls who go to school should do their share. They can organize sanitary and service squads. Some of these

squads can supervise the lunch room at meal times; others can help in the morning inspection of pupils



The school nurse helps us to keep well.

by acting as health officers in their own individual divisions or classrooms. They can all work together to increase the spirit for better living and for better working conditions in the schools and in the community.

Use of the score card. —

The object of this card is to compare our community in various ways with the ideal or perfect one. Of course, if we are honest with ourselves, no matter how much we wish to “boost” our home town, we shall be fair in our scoring. Otherwise there is no value in the exercise. We wish to know how we may make bad conditions better. The score card should show up the weak points of the community and enable us to improve it.

GENERAL SCORE CARD OF MY ENVIRONMENT

		PER- FECT SCORE	MY GUESS SCORE	MY FINAL SCORE
NATURAL RESOURCES, ADAPTATION FOR MAKING A LIVELIHOOD	Soil adapted to cereal crops	(20)		
	Soil adapted to market gardens	(20)		
	Forests give opportunity for community business	(20)		
	Land suitable for grazing	(20)		
	Land suitable for fruit growing	(20)		
	Presence of natural waterways	(20)		
	Presence of ores for mineral wealth . .	(20)		
	Natural fuels abundant	(20)		
	Fish sufficient for industry	(20)		
	Selection from such groups as offered by your community not to exceed 100			
		100		

USE OF THE SCORE CARD

257

GENERAL SCORE CARD OF MY ENVIRONMENT—Continued

		PER- FECT SCORE	MY GUESS SCORE	MY FINAL SCORE
CLIMATE AND WEATHER	Not great extremes of temperature . (20) Moisture plentiful . (20) No danger from tornadoes or lightning (20) Freedom from hail, early frosts, and high winds . (10) No long periods of severe heat or cold (20) Freedom from floods (10)			
RELATION OF WATER TO PRODUCTION	Water power gives community source of business, many factories, power cheap (60) All power utilized (20) Near-by farms well watered (20)	100		
COMMUNITY WATER SUPPLY	Water from pure source (20) Water safe, no epidemics (10) Water supply safeguarded, filtered . . (10) Water desirable, soft, no color or taste (20) Adequate supply, good pressure . . . (20) Public fountains and baths (10) Cost moderate (10)	100		
COMMUNITY CARE OF FOOD	Milk supply inspected (10) Milk supply pure (10) Milk graded and pasteurized (10) Inspection of meats and slaughter houses (15) Inspection of groceries and stores . . (15) Inspection of bakeries and products . (15) Inspection of restaurants and soda fountains, proper care demanded . . (15) Supervision in sale of patent medicines and adulterants (10)	100		
INSECTS AND CITY CLEANLINESS	No breeding places for mosquitoes. All standing water entirely eliminated or protected by oil or introduction of fish. No mosquitoes present (50) If culex only is present, score (30) If anopheles is present, score (0) No breeding places for flies found, manure heaps frequently moved, no open privies, no rubbish in vacant lots, screening and inspection of markets, no flies (50) Some flies but not annoying, score . . (30) If flies are present in swarms, score . (0)	100		
WORK OF BOARD OF HEALTH	Board of Health active, efficient, well provided with equipment, laws enforced on quarantine and disinfection, free antitoxins, and serums. Ample hospital equipment (35) Law enforcement of all health measures and coöperation with schools, homes, and civic organizations (35) Adequate laws with reference to proper housing conditions are enforced. Factories and stores are sanitary and safe. No fire trap (30)	100 100		

GENERAL SCORE CARD OF MY ENVIRONMENT—*Continued*

		PER- FECT SCORE	MY GUESS SCORE	MY FINAL SCORE
COMMUNITY SAFEGUARDING OF LIFE AND PROPERTY	Streets well lighted at night (15) No grade crossings (5) Efficient police system (25) Efficient fire department and fire laws and regulations (35) Traffic laws and signals (5) Coöperation on the part of State and Civic organizations in protection of life and property (15)	100		
ADVANTAGES FOR EDUCATION, RELIGION, SOCIAL LIFE AND RECREATION	School system complete and adequate, having elementary (5), secondary (5), technical (5), normal school or college (10), special schools for deficients and defectives (10) . . . (35) Free library (10) Churches, active (15) Social agencies, active (15) Museums, concert and lecture courses free (10) Public parks, playgrounds, and baths free and adequate (10) Movies, theaters, and recreational cen- ters (5)	100		
TRANSPORTA- TION AND COMMUNICA- TION	Streets well paved and in good repair, trees abundant (12) Roads connecting surrounding com- munities well paved and kept in re- pair (15) Adequate trolley, jitney, and steam passenger service (16) Adequate freight service (12) Canal or other water transportation . . (12) Air transportation developed (4) Parcel post and mail service adequate . (12) Telegraph and telephone (8) Fire and police system (4) Daily newspapers (5)	100		
	GRAND TOTAL	1000		

REFERENCE BOOKS

- The American City Magazine.* Articles of mutual interest to both teachers and students. New York.
- Farwell, *Village Improvement.* (For teachers.) Sturgis and Walton Company.
- Finch, *Everyday Civics.* American Book Company.
- Forbush, *Young Folks Book of Ideals.* Lothrop, Lee, and Shepard Company.
- Geddes, *Cities in Evolution.* (For teachers.) Williams and Norgate.
- Howe, *The Modern City and its Problems.* (For teachers.) Charles Scribner's Sons.
- James, *Building of Cities.* The Macmillan Company.
- Lewis, *The planning of the Modern City.* (For teachers.) John Wiley and Sons.

CHAPTER XVII

HOW THE COMMUNITY CAME INTO EXISTENCE

Problems. — 1. *To learn something of the earth as a planet and of its early history.*

2. *To learn how the earth became prepared for life.*

3. *To learn what forces are constantly at work changing the earth's surface.*

4. *To learn about the life of early man.*

5. *To learn how community life began.*

6. *To learn the part natural resources play in the formation of a community.*

Suggested projects. — 31. To make a collection of local rocks, minerals, and soils.

32. To learn what the natural resources of my community are and to what extent they are used.

How the earth became inhabitable. — Any boy who has climbed to the summit of a hill or a mountain knows the feeling with which he looks out over the expanse below. We are alert to pick out this or that familiar landmark, we spy out forests here and fertile fields there, a lake nestling among the hills, a little town or river in the valley, perhaps a big city far off on the shore of some large body of water. We have that feeling of elation which comes to any of us after we have accomplished something worth while, and we feel that the world spread out below us is a

pretty fine place to live in, after all. How many of us, do you suppose, think back into the distant past and ask, "How did all these wonders of mountain and plain, hill and valley, river and lake, rock and soil, come into existence?"

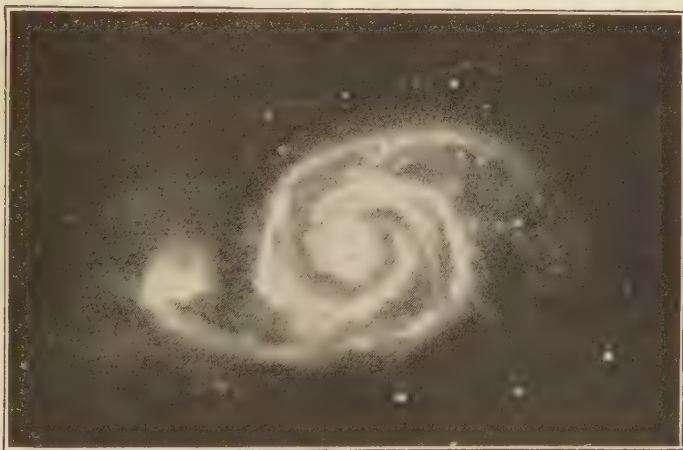


We view the mountains, the valley, and the river, and wonder if they have always existed as we now see them.

Were they always just as they are now? Or did the earth grow and change, much as the living things which we know do?"

How the earth was formed. — Scientists believe that the earth, and the other planets as well, have grown gradually by accumulation of solid particles from space (*planetissimal theory*), or they have been evolved from gaseous bodies into their present form (*nebula theory*). According to the nebula theory, the entire solar system

was a mass of rapidly whirling gas. From time to time portions of this gas were thrown off by centrifugal action and later each mass thus separated became a planet. One of these bodies formed from a detached fragment of the sun was the earth; thus the entire earth was at one time in the form of hot gases. As these cooled, those substances which form the solid portion of the earth condensed and



A nebula from which new stars or suns, and new planets like the earth, may be in process of formation.

solidified first, leaving a surrounding atmosphere of less easily condensed gases. In the course of time as the earth's surface cooled, water must have come from the atmosphere by condensation. In this way the rivers, lakes, and oceans received their supply of water from the atmosphere.

Demonstration Experiment. — To see the effect rotation (centrifugal motion) has upon a body.

Materials: A one-liter flask. Colored water. Stout cord.

Method: (1) Pour 50 c.c. colored water into the flask. Tie a cord tight around the neck and suspend it from a double cord four feet



long. This suspension cord must be fastened to the flask so that it lies in a vertical axis running through the center of the neck of the flask. Twist the cord many times by turning the flask. When left free the cord untwists and the flask is rotated rapidly.

(2) Repeat (1) using a flask which has several small holes blown through its walls at the level of its greatest diameter.

Results and Conclusion: What happens to the colored water in (1)? in (2)?

What effect does an increase in speed of rotation have in case (2)?

Application: Apply results seen here to explain one phase of the action by which the earth was formed according to the nebula theory.

The age of the earth. — Various methods have been worked out by scientists to determine the time it has taken for the earth to assume its present form. One way is to estimate the amount of salt in the ocean as a measure of its age.¹ Assuming that the water was originally condensed from the atmosphere as rain the time it would take for the ocean to get its present content of salt from the earth could be computed with a fair degree of accuracy. The latest estimate based upon this method makes the oceans a little less than 100,000,000 years old. The age of the earth itself must be much greater. Some scientists estimate up to 400,000,000 years.

Early beliefs. — The early beliefs concerning the earth seem rather ridiculous to us now. When we remember that as late as the time of Columbus the majority of educated people in Europe believed that the earth was flat, and that the sun moved around it, we can appreciate the advances made in recent years. Copernicus, a native of

¹ T. C. Chamberlain, "The Evolution of the Earth." *Scientific Monthly*, 1916.

northern Europe, proposed in 1530 the now well-known explanation that the sun was the center around which the planets moved. This theory was slow in being accepted, and half a century later Galileo, by the use of his newly invented telescope, added new observation to the theory of Copernicus and helped in its establishment. Still later, about 1660, Sir Isaac Newton recognized that the pull of the earth upon objects was a universal thing and could be applied as a law to other planets as well. The attraction of the earth for bodies near its surface is called *gravity*. Gravity causes unsupported bodies to fall and is measured



In what regions are these two types of vegetation found?

in units of weight. Gravitation is the force with which any one body in the universe attracts every other body. Members of the solar system move according to this law.

Temperature. — The effect of temperature on the living things upon the earth is familiar to us in a general way.

Geography has taught us something about the various zones of life upon the earth. Temperature is one of the greatest factors in determining the kind of life and the amount of it found in a given region. The lack of plant life in the arctic regions and the wealth of vegetation in the tropics are due largely to the difference in temperature in the two regions.

How the earth became prepared for living things. — The world would have looked like a strange place to us had we



Surface of a lava flow.

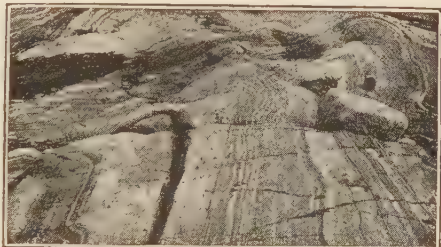
been able to view it as it first became cool enough to sustain life. Probably its surface, though very irregular and holding bodies of water in its depressions, was not carved into mountain ranges and separated by deep val-

leys as it is now. It was an age of volcanic action and we may imagine that either great craters or active volcanoes were present almost everywhere. These volcanoes, vents from the superheated interior of the earth, poured out molten rock or threw off with the heated vapor masses of powdered material that became the first soil of the earth. Bare rocks protruded everywhere in a chaos of wildness, broken only by the dark sullen bodies of water. No life of any kind, plant or animal, could be seen. It was this bleak, lifeless earth that has been transformed into the beautiful world covered with vege-

tation that we know. How were all these things brought about?

Rocks — what are they? — Rock is a common sight to all of us. We see it used for building purposes, for paving, both in the streets and on the sidewalks. Farmers go to some trouble to remove small loose rocks or stones from

their fields and build them into walls. And most of us know that if we dig into the earth, sooner or later we shall come to solid rock. The island of Manhat-



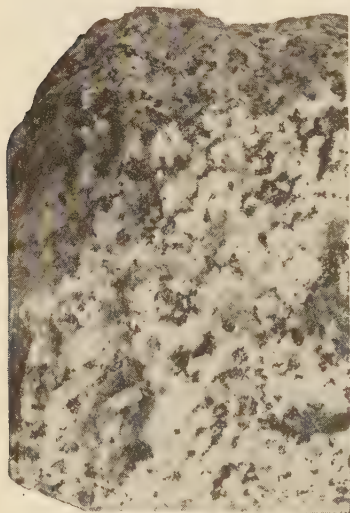
Twisted gneiss rock.

tan, for example, is almost a solid mass of rock. If we examine such rock closely, we see it is twisted or contorted as if it had once been soft or molten, and had been squeezed together. The first rock on the earth is believed to have been of this kind.

Experiment. — To see if natural surface waters contain a rock sediment.

Kinds of rock. — In former ages, as now, water has played an important part in wearing away rock masses and bringing the powdered material down in its current to a larger body of water. Enormous quantities of rock sediment are brought to the oceans by all large rivers, forming deposits, which in time, become miles in depth so that the lower layers are subjected to tremendous pressure and heat and the particles are cemented together into rock. In this way sandstone is formed. Rock of this nature, formed from deposits made under water, is *sedi-*

mentary rock. Because this shows layers in its formation it is called *stratified rock* also. Rock like granite, which was formed by cooling from a molten condition, is *igneous rock*. All the rocks of the earth are in, or have belonged to, one of these two classes. A rock of either class may undergo a change of partial melting and develop new



Granite, an igneous rock.



Gneiss, a metamorphic rock.

crystals and a different appearance, from twisting, folding, or flowing. It is then called *metamorphic rock*. Gneiss, slate, and marble are examples of metamorphic rock. Small amounts of rock are produced by deposit from water solution, as for example the stalactite of limestone caves.

Experiment. — To learn how to identify a few common rocks.

Methods of erosion. — It is common knowledge that heat causes substances to expand and occupy more space,

while cold, on the other hand, causes them to contract. When water freezes, however, the ice formed is larger than the water from which it came. Thus when water in the cracks of rocks freezes it expands and forces the rocks apart. The hot rays of the sun melt the ice on the high mountains during the day in summer. At night the water freezes again, and this process, kept up day after day, eventually cracks the hardest rocks.

Experiment. — To show the expansive force of freezing water.

A large mass of moving ice, as a glacier, is a powerful grinding agent as it carries down rock fragments which, under the pressure of the glacier, grind the rock beneath into fine particles. Thus



An Alpine glacier. See the three streams of rock fragments torn from the sides of the valleys. Note how the glacier hollows out the rock through which it flows. (After Cleland.)

many of the streams issuing from the foot of glaciers are white with the rock sediment carried away by them. These methods of breaking rock into small particles are among the most important methods of *erosion*.

Erosion by water. — Many of our western peaks and

the mountains of Switzerland are huge rock masses which are being worn slowly away by water. The force of the water, tearing loose the big boulders, rolls them downstream one against another, and finally grinds them into powder. In many a mountain stream to-day we may see



A gorge formed by water erosion.

this powdered material going down with the turbid water. Rock particles are carried until they finally reach the river's mouth, where the current, entering the ocean, slows up and the load is dropped. Thus *deltas* of new soil are formed.

Erosion by wind.

— In many parts of the world, the wind has an important part in soil making. You

have all seen a sand blast, and have noticed that the tiny particles of sand, driven by a current of air against the outer surface of a building, will in a short time change the appearance of the surface. In some parts of the West the wind drives millions of particles of sand against the sandstone cliffs with such force that they are worn down and hollowed out by this natural "sand blast."

What is soil? — We have thus seen that soil in its original form, is ground-up or powdered rock. The character of the soil depends upon the kind of rock from which it is produced. Sand, for example, is rather coarse material usually containing a good deal of silica. Clay, on the other hand, is very finely powdered rock, and may be of various colors, depending upon the mineral substance with which it is impregnated. Such soil is *inorganic*, and without living



Erosion by wind-driven sand.

material of any kind. But soil, after plants and animals appeared on the earth, became mixed with dead forms. The addition to the inorganic soil of *organic* matter, derived from dead animals and plants or products of them, makes the rich black soil we call loam.

The coming of life on the earth. — Just how and when life came to the earth we do not know, but it must have been a good many millions of years ago. Probably at first the water became the home of tiny one-celled plants and possibly animals as well, and as time went on more and more complex forms came into existence. We frequently find fossils, remains or traces of plants and animals which lived upon the earth in former ages, preserved in the rocks. By means of a study of these fossils which are embedded in different kinds of rocks and at different depths, we have been able to form quite a definite history of the development of life upon the earth. It was in this

way that we learned that as life developed on the earth, plants and animals became more and more complex, until



Rock containing fossils.

finally the types found upon the modern earth came into being.

The life of early man. — Think of a world without any modern conveniences, without homes, without fires even. Such was the world of primitive man. He was a wanderer and lived like the wild beasts which preyed upon him and which he killed with his

own hands for food. At first these people probably lived in caves, and we can imagine how the discovery of fire must have added to their comfort as well as their safety. They must have been skilled hunters, for piles of bones have been found near their ancient camps. Gradually they must have learned to use implements as well as weapons, made at first of stone and later of bronze and iron. Then came the discovery that the seeds of certain wild grasses were good to eat. When grains were cultivated, and animals domesticated, there was the beginning of a fixed home.

How a community came to be formed. — In the early days people lived in large families or clans and had certain

tribal customs. All the members of a clan lived according to the customs of that clan. Often these people lived in deadly enmity with those of other clans and, as in the case of our North American Indians, they hunted and lived together for mutual protection. Later people built walled towns, often on the hilltops for protection against their hostile neighbors; thus the first communities were formed.

First settlements in this country. — When the early settlers came to this new world, they were exposed to unfriendly natives, the Indians, and they lived together not only for the sake of protection, but for other reasons also. Towns were settled in locations of natural advantages which gave the inhabitants opportunities for trade, water power, or agriculture. The people who settled in these early communities wanted social life as well and churches, schools, and public meeting houses were built. At first life was very simple and there were few trades or occupations. Each man was his own carpenter, tailor, and shoemaker. As the settlement grew in numbers some men who were good carpenters took that as their trade, others became tailors, and still others,

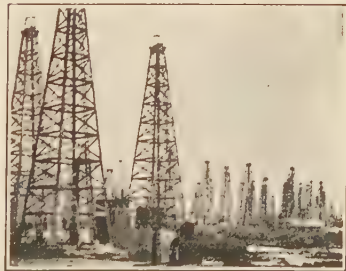


A North American Indian.

shoemakers. Thus the modern community with its complex life developed and its many advantages came into existence.

Natural resources. — Man in his primitive state needed food, shelter, fuel, and clothing. These primary needs, as civilization grew, were supplemented by many others. Indians who inhabited wooded territory had all the fuel they needed, and if this became exhausted they moved to a new supply. Now great manufactories have come into existence, particularly where there is an abundance of different fuels, — wood, hard and soft coal, oil, and natural gas. From these fuels they obtain coke and gas, and may produce electricity. The raw materials near at hand are likely to determine the kind of goods manufactured in a community.

An inventory of our natural resources. — Since our communities are so dependent upon these resources it will be well for us to make an inventory of them and then we can appreciate why the United States has become such a wealthy nation. We have the fertile plains of the Middle West, great forests which are almost untouched in the Northwest and in parts of our Northern states, cotton, cane, citrus fruit and truck farms in the Southern states, and the vineyards and orchards of New York and California. All of these indicate a richness and fertility of land. A visit to the farms in the central West shows us that different localities create different kinds of wealth: pigs in Iowa, cattle in Texas and the central West, sheep in the mountain states, the great slaughtering and packing industries in St. Louis, Chicago, and Omaha. The fishing industries of the eastern and western coast and of the Great Lakes must not be forgotten, neither must the re-



Sheep raising, fishing, lumbering, mining, quarrying, and oil drilling are among the industries which depend upon our natural resources.

sources, now almost exhausted, of wild bird and other animal life. Then we have the iron mines of Minnesota, the copper of Michigan, the gold of the mountain states and Alaska, the coal of Pennsylvania and Illinois, the oil

fields of West Virginia, Oklahoma, and California, all testifying to the richness of our natural resources. Although the United States has only 6 per cent of the world's population, and only 7 per cent of the land of the globe, yet it produces a large part of the world's supplies as shown by the following table:

THE UNITED STATES PRODUCES OF THE WORLD'S SUPPLY:

Aluminum	60 %	Corn	75 %	Iron and Steel	40 %
Automobiles	85 %	Cotton	60 %	Lead	40 %
Coal	52 %	Gold	20 %	Silver	40 %
Copper	60 %	Oil	66 %	Wheat	25 %

REFERENCE BOOKS

- Bishop and Keller, *Industry and Trade*. Ginn and Company.
 Brigham and McFarlane, *Essentials of Geography, Book II*. American Book Company.
 Browne, *Peeps at Industries. Rubber*. A. and C. Black.
 Browne, *Peeps at Industries. Sugar*. A. and C. Black.
 Browne, *Peeps at Industries. Tea*. A. and C. Black.
 Cleland, *Geology, Physical and Historical*. (For teachers.) American Book Company.
 Clod, *The Childhood of the World*. The Macmillan Company.
 Dryer, *High School Geography*. American Book Company.
 Fisher, *Resources and Industries of the United States*. Ginn and Company.
 Gowin and Wheatly, *Occupations*. Ginn and Company.
 Gregory-Keller-Bishop, *Physical and Commercial Geography*. Ginn and Company.
 Hunter, *A Civic Biology*. American Book Company.
 Kissell, *Yarn and Cloth Making*. (For teachers.) The Macmillan Company.
 Rolt-Wheeler, *The Boy with the United States Foresters*. Lothrop, Lee, and Shepard Company.
 Rolt-Wheeler, *The Boy with the United States Fisheries*. Lothrop, Lee, and Shepard Company.
 Rolt-Wheeler, *The Boy with the United States Survey*. Lothrop, Lee, and Shepard Company.
 Samuels, *The Story of Iron*. Penn Publishing Company.
 Shaler, *Aspects of the Earth*. Charles Scribner's Sons.
 Snyder, *Everyday Science*. Allyn and Bacon.
 Werther, *How Man Makes Markets*. The Macmillan Company.
 Zitzler and Jaquette, *Our Community*. J. C. Winston Company.

PART VIII. WEATHER AND CLIMATIC CONDITIONS

CHAPTER XVIII

THE EFFECT OF CLIMATE ON COMMUNITY LIFE

Problems. — 1. *To learn the causes of the seasons.*

2. *To learn the relation of temperature, rainfall, heat, and cold to communal life.*

3. *To learn about air conditions affecting weather.*

4. *To understand the use of weather instruments.*

5. *To learn the nature of cyclonic storms.*

6. *To learn about the work of the weather bureau.*

7. *To learn how wealth is influenced by climate.*

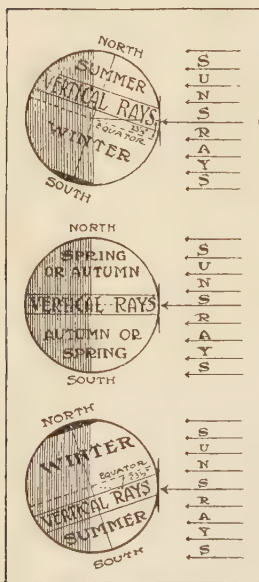
Suggested project. — 33. To keep a weather record for 10 weeks.

Climate and civilization. — In one of the most interesting scientific books that has recently been written, Professor Ellsworth Huntington points out that civilization and progress go hand in hand with a favorable climate.

We are told that the first Pilgrim settlers were much disappointed at the severity of the New England climate. But, they owed their sturdy growth and endurance, in part at least, to the great changes in the climate to which they were exposed. We also, who have received their heritage, owe much of our prosperity and leadership among the nations on the earth to the climate we enjoy.

The seasons and how they are caused. — We remember, of course, that the earth revolves around the sun, making a complete circuit once in about 365 days, and that as the earth goes spinning through space, it rotates on its own axis once in 24 hours. While the earth is thus revolving

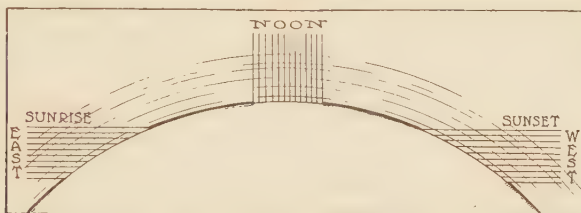
around the sun its axis is inclined towards the plane of its orbit. (See diagram.) Thus the sun's rays strike a given place on the surface of the earth in a more slanting direction at certain seasons than at others. Early in the morning hold a piece of perforated cardboard about one foot from the floor, and perpendicular to the rays of light, so that the sun's rays will pass through the hole, and measure the area of sunshine on the floor. Repeat the experiment at noon and compare the area of sunshine on the floor with that measured in the morning. The rays meet the surface of the earth more nearly at right angles at noon, hence they cover less



The cause of the seasons explained.

space. If the earth receives the sun's rays less perpendicularly, they are spread over a greater surface and we receive less heat on a given surface. (See diagram.) The seasons, also, depend upon the angle at which the sun's rays strike the earth. If we look at the diagram, we notice that in a similar manner the heat of the torrid zone and the lack of heat at the poles of the earth are due to this

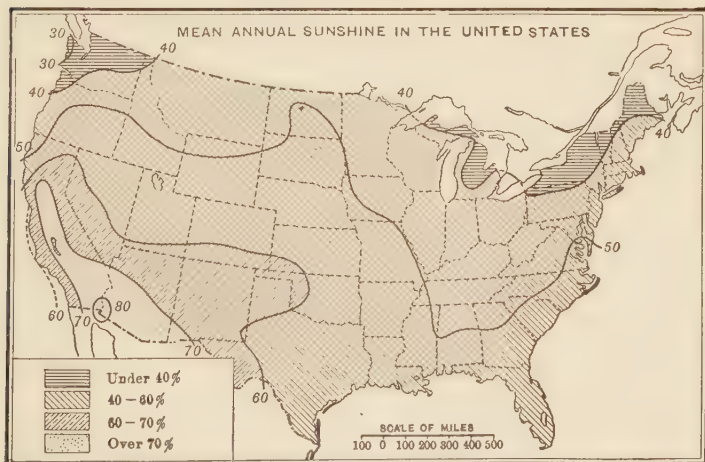
same fact. The sun is north of the equator in summer and south of it in winter. Can you explain why this



Notice that the beam of sunlight covers a smaller area of the earth's surface at noon than at any other time.

should give us a hot season in the one case and a cold one in the other?

Sunlight — a factor in climate. — We have learned already that sunlight is a very important factor in and



about our homes. Sunlight determines, very largely, the temperature, and so has an indirect influence upon the growth of plants. Sunlight plays an important part in

our daily industrial life as a study of the map on p. 277 will indicate. Let us now try to find out something about a few of the causes for lack of sunshine.

Weather and climate. — We observe the various changes in the atmosphere which come to us day by day. It may be clear or cloudy, calm or windy, hot or cold, wet or dry. We speak of these variations as changes in weather, and the average weather, taken day by day, week by week,

WHITEHALL BUILDING
17 BATTERY PLACE

U. S. DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU.
CHARLES F. MARVIN, Chief

SATURDAY
FEBRUARY 5, 1921

Highest yesterday 41°

FOR NEW YORK CITY AND VICINITY

Lowest last night 36°

Rain to-night. Sunday fair, colder. Moderate south to west winds. Minimum temperature to-night about 36 degrees.

EASTERN NEW YORK: Rain to-night, colder in extreme northern portion. Sunday cloudy and colder, probably rain or snow in north and central portions. Fresh south, shifting to west winds.

EASTERN PENNSYLVANIA: Rain to-night, warmer in south portion. Sunday generally fair and colder, except probably rain or snow in extreme north portion. Moderate south, shifting to west winds.

NEW JERSEY: Rain to-night. Sunday fair and colder. Moderate to fresh south, shifting to west winds.

SOUTHERN NEW ENGLAND: Unsettled to-night and Sunday, probably rain; warmer to-night; colder Sunday afternoon. Fresh south, shifting to west winds.

STEAMERS departing to-day for European ports will have fresh south, shifting to west winds and rain to the Grand Banks

Shipments of perishable produce should be prepared for the following temperatures Sunday morning:

Northern New York, 18° to 28°—

Northern New England, 18° to 30°—

Southern New England, 30° to 40°—

Western New York, 28° to 38°—

Western Pennsylvania, 32° to 40°—

Eastern Pennsylvania, 32° to 40°—

New Jersey, 32° to 40°—

+ indicates followed by warmer. — Colder.

A sample of information distributed by mail by the Weather Bureau.

season by season, makes up our climate. These changes which occur in the weather can be predicted with some accuracy by any one who has made a careful study of clouds, winds, and air pressure.

Air pressure in its relation to weather. — We have already learned that air has weight. Its pressure at sea level averages about 14.7 pounds to the square inch. We sometimes get a little idea of this pressure by being suddenly dropped down in a rapidly running elevator, at which time the change of air pressure may be noticed in its effect on the ears. The instrument which measures the pressure of

the air by the height of a column of mercury is called a *barometer*. Torricelli, a pupil of Galileo, was the first to make a simple barometer.

Demonstration Experiment. — To make an experimental barometer.

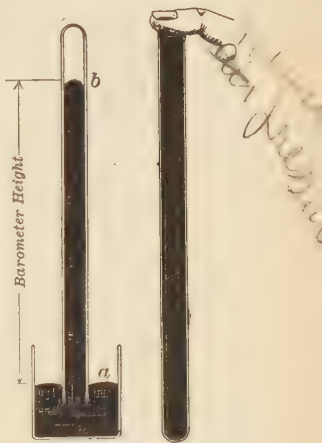
Materials: A stout glass tube 33 inches long, closed at one end. Mercury. Small funnel. Mercury trough.

Method: Hold the glass tube inclined a little from vertical. Place the funnel in the tube and pour in mercury to fill the tube. A suitable funnel may be made by heating the stem of a thistle tube near the bulb and drawing it out to reduce the diameter. Cut this off at its narrowest point. Work the air out of the tube by causing a bubble of air to run the length of the tube and back again. When the tube is full of mercury, cover the open end with the finger, invert, hold end under mercury in the trough, and remove the finger.

Result and Conclusion: What happens when the finger is removed? Hold the tube vertically and measure the height of the column of mercury in the tube above the level of mercury in the trough. What holds it up? Read the barometer. Why does this experimental barometer read lower?

Application: How may a barometer be of value in your home?

Note: A barometer made in this way has some air left in it and so reads lower than a standard barometer. The air can be removed only by boiling the mercury in the tube.

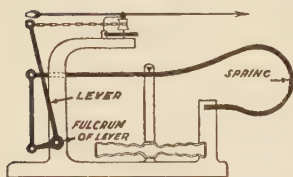


Experimental barometer.

How a barometer is used. — The height of a column of mercury under standard conditions is 30 inches and represents an air pressure of 14.7 pounds per square inch. A rise or fall of the column indicates an increase or decrease in air pressure. The air pressure in any locality depends on the altitude above sea level; for example, Leadville,

Colorado, with an altitude of over 10,000 feet, shows a height of mercury of only 20 inches. The air pressure decreases up to an altitude of 10,000 feet at the rate of approximately 1 inch for each 900 feet. A fall of 1 inch

in the barometer represents a rise of 910 feet near the earth and 1500 feet three miles above sea level.



Explain the working of the aneroid barometer from this diagram.

Aneroid barometer. — The *mercurial barometer* cannot be carried about easily, as it must be kept in a vertical position. A portable type, called the *aneroid barometer*, contains a small flat box of thin corrugated metal. Removal of some of the air from the box makes a partial vacuum within it. A slight increase in pressure causes the walls of this box to come closer together, while a decrease in pressure allows them to go farther apart. This

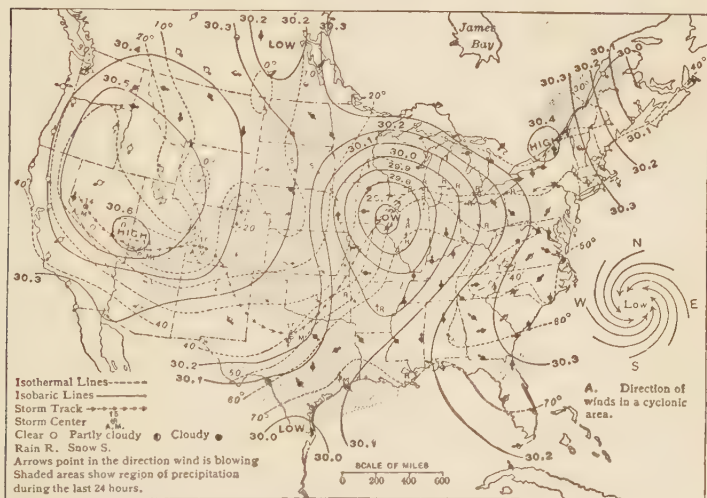
motion is transferred by lever action to a hand which moves along a scale and shows the pressure of the atmosphere. The aneroid is used both for weather observation and to measure the height of mountains or the altitude of aircraft.

Experiment. — To measure height with an aneroid barometer.

How the barometer foretells storms. — The United States Weather Bureau makes use of the barometer in forecasting changes in the weather. It has found by ex-

perience that a "rising barometer" which means an increase of atmospheric pressure, indicates fair weather. A "falling barometer" or decrease of atmospheric pressure, usually means an approaching storm. A steady high barometer means settled clear weather.

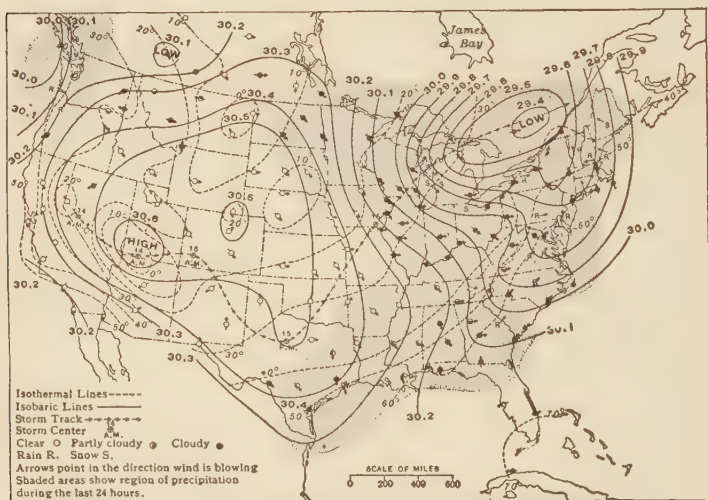
Let us apply this knowledge to the study of the weather maps issued daily by the weather bureau.



Tell the story of the weather as disclosed by this map.

Cyclonic storms. — If we study the weather maps we notice wherever the air pressure is low little arrows point approximately toward that spot and that these arrows show that the wind is moving spirally counter-clockwise around this point of low air pressure. This rotary movement around and toward a low-pressure area is called a *cyclone*. Cyclonic storms pass across the United States from the northwest, southeasterly to the Mississippi Valley,

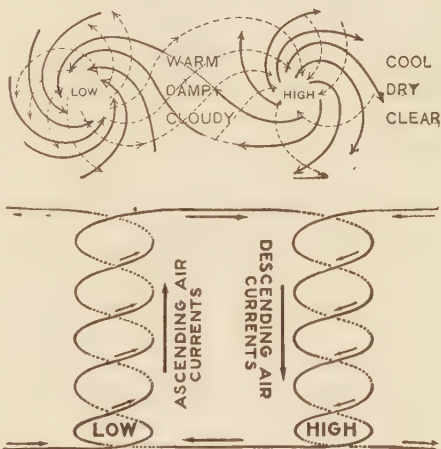
then northeasterly, usually leaving the continent along the St. Lawrence Valley. They move rather slowly, at the rate of about 25 miles an hour in summer and about 35 miles an hour in winter. These cyclonic storms occur with considerable regularity in the winter, each cyclonic storm being followed by an *anticyclone* or area of high pressure, from which winds blow in a clockwise spiral.



Weather conditions 24 hours later; what important changes have occurred?

What causes cyclonic storms. — Areas of low pressure have high temperatures and much moisture in the air. High-pressure areas have low temperatures and little moisture in the air. Warm air is lighter than cold air. Moist air is lighter than dry air. The heavy, dry, cold air of the “high” is drawn down by gravity with greater force than is the light, moist, warm air of the “low,” so the cold air flows in under the warm air and lifts it. About the

center of the "low" there is always an ascending current of moist air; and about the center of the "high" there is a descending current of dry air. Complete convection currents are thus established. At the surface of the earth there is a movement of air or wind from the "high" to the "low." In the upper layers of air above the earth there is a current of air from the "low" to the "high," thus completing the circuit of moving air. Practically all of our variable winds are caused by natural convection currents in the atmosphere. The trade winds and prevailing westerlies are influenced largely by the rota-



[Explain these figures.]

tion of the earth as well as by convection. In addition local conditions, as the presence of mountains, valleys, forests or bodies of water may influence weather conditions.

Thunderstorms and tornadoes. — There are two general types of local storms, thunderstorms and tornadoes. The former are rarely over twenty to twenty-five miles in width and as a rule travel not over two hundred miles. Electricity seems to be present in the air up to a height of many miles. During clear and dry weather the electrical energy is fairly equally distributed, for dry air is a very poor conductor of electricity, but during rapid cloud for-

mation great differences in the electrification of the air occur, and since moisture aids the conduction of electricity, the result is that a cloud may become charged with a bountiful supply. The electricity is discharged from the cloud by means of a flash of lightning, either to another



Observe the similarity between the natural and the artificially made electric flashes.

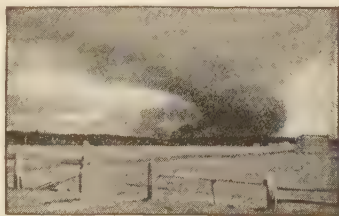
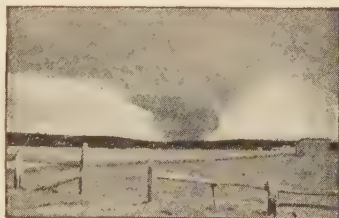
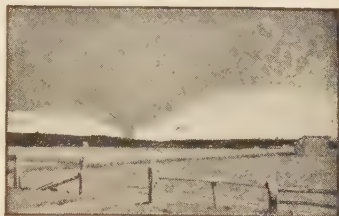
cloud which is oppositely electrified or to the earth. Considerable damage is done during thunderstorms by burning barns and forest fires which have been set by lightning. Tornadoes usually occur along the valleys of the Missouri and Mississippi rivers, and occasionally in some parts of the Ohio Valley, as well as south and east. They are

extremely local storms, frequently varying from fifty to one thousand feet in width and traveling only a few miles usually. A whirling motion develops in the rising column of air, and when of great intensity, the characteristic funnel, which is only a part of the cloud itself, is formed. Air is believed to rush around in this whirlwind at the rate of three to five hundred miles an hour, and wherever the funnel of the tornado touches the ground, it sucks up and destroys everything in its path.

Formation of clouds and rain. — As the moist, warm air rises it expands, and when it expands, it becomes cooler.

Cooling air reduces its capacity to hold moisture. As a result, at some height, conditions are such that the moisture in the air is condensed into clouds. The minute particles of moisture in the clouds may increase in size by further condensation upon them, or several particles brought into contact may unite, so that finally the particles are too heavy to remain suspended in the cloud and they fall as rain.

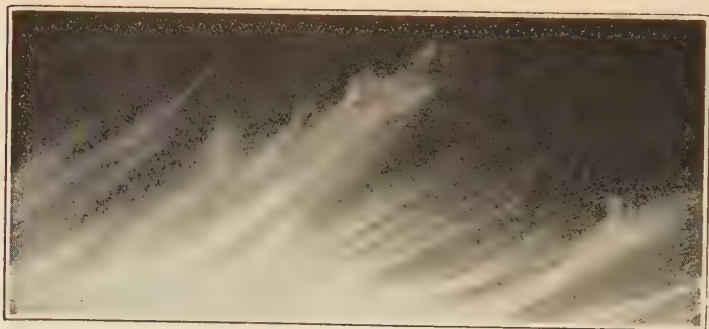
Dew and frost.—In somewhat the same way as moisture is condensed in the clouds to form rain it may also be condensed on objects and appear as dew. Vegetation holds little heat, losing it by radiation soon after the sun goes down. Grass thus cools the air immediately in contact with it, and moisture in the air is condensed on the surface of the blade of grass. When the temperature of the air



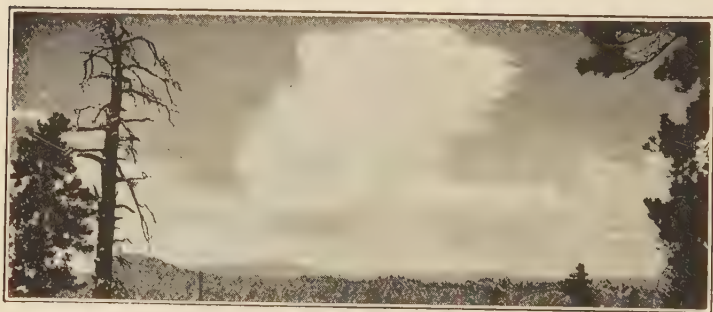
A Tornado.

is at the freezing point or below it, the condensed particles of moisture are frozen into small crystals of ice or frost.

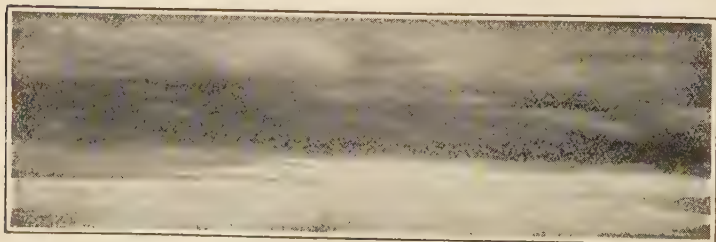
We see that plants need water no less than people do. Rainfall makes the type of community. Farming depends to a large extent upon the amount of rain and sun. If the summers are hot, rain becomes a necessity, both for



Cirrus clouds; found at an altitude of five miles or more above the earth.

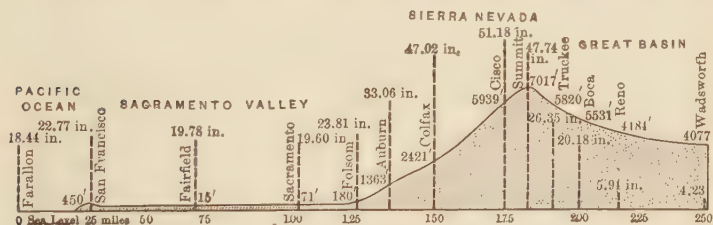


Cumulus clouds; often the forerunner of a thunderstorm.



Stratus clouds; low-lying clouds.

the protection of the soil and for the plants and seeds that are in it. A study of the accompanying diagram shows that the rainfall differs very considerably, within a range of 250 miles. Colfax and Wadsworth, distant from each other only 100 miles, differ in annual rainfall almost 43 inches. How do you account for this difference? Twenty inches a year is a minimum for dry farming, and a rainfall of from 30 to 50 inches is best for the great cereal crops of our country. In the great Middle West, where the rainfall is from twenty to thirty inches a year, wheat is the staple crop, while in the East and the South there are



more diversified crops, due to the fact that the rainfall is much greater, being between 40 and 70 or more inches.

Influence of water upon climate. — It is pleasant for us in the hot summer to make visits to the seashore or to a mountain lake. If we think back to the chapter on heating rooms, we remember that the stove set up convection currents. The same thing occurs on a larger scale between land and bodies of water. During the day the temperature of the land rises higher than does the temperature of the water. The heated air rises from the land, and as it does so, cooler and heavier air makes its way from the water to take its place. This accounts for a breeze and a more even temperature in the city or town located near a body

of water. In the winter months the lake or ocean loses its heat more slowly than the land and so prevents extremely low temperatures in its vicinity.

The effect of storms. — We have seen that bodies of water influence winds. Such winds make life bearable in many tropical countries, especially where the trade winds blow in from the ocean at certain intervals during the day, causing evaporation, which is a cooling process. The



A flooded city, the result of heavy rainfall causing rivers to overflow their banks.

presence of wind belts over ocean and land is well known to all those who have studied geography. Our cyclonic storms occur in one of these wind belts. These storms, while they do damage, supply the needed rainfall. Thus the eastern part of this country owes much of its fertility to such storms. On the other hand, prolonged and severe rainfall at times causes rivers to overflow their banks, doing much damage to crops, to buildings, and to railroads. Local conditions, such as high hills, mountains, lakes, or forests, may have a great effect upon the pre-

vailing winds, and do much in making the location a pleasant or an undesirable place in which to live.

Changes in temperature in relation to community life. — Tropical climates or extremely cold climates are unfavorable in their effect on mankind. We have already spoken of this and we know that Northerners going into the tropics soon lose their ambition and settle down to an easy life and short hours of work. This seems to be due to the lack of stimulation in such a climate. In the far north there are long periods of darkness, and the monotony brought about by the lack of changes in temperature and light causes an unfavorable reaction on the people living there. The moderate changes which come in a temperate climate, especially the cold winters and warm summers, undoubtedly do much toward making our people active and resourceful. A recent study of temperature by a committee on ventilation in New York State found that 15 per cent less work was done by a group of people working in a temperature of 70 degrees Fahrenheit than when the same group worked in a temperature of 68 degrees Fahrenheit; while if the heat became as high as 86 degrees they did 37 per cent less work than they did at 68 degrees. This shows the favorable effect of moderate temperature on industry.

Industry affected by climate. — It goes without saying that such industries as farming or lumbering depend largely upon climate. Many manufacturers as well, especially those who use the products of the farm or raw lumber, build their factories near the source of supply. Others who make use of water power are indirectly dependent upon the climate also. More than this, workmen in factories, or indeed in any occupation, are very greatly influ-

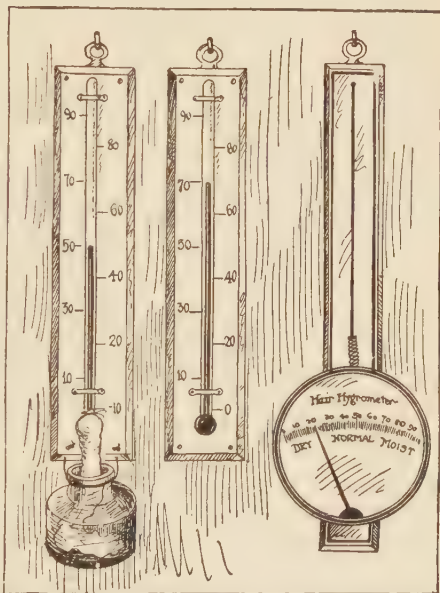
enced by the amount of moisture or the humidity of the atmosphere.

Experiment. — How we measure humidity.

Humidity. — What do we mean by humidity? We have felt one effect of it, for the discomfort of a muggy day in summer is caused by it. If we place a dish of water in an air-tight box, the water will evaporate until the inclosed space holds all the water vapor it can. Then the air is said to be *saturated*, but we really mean that the *space* is saturated, because there would be the same amount of moisture in the space whether air were present or not. The weight of water which a cubic foot of air or space actually holds is called the *absolute humidity*, but the humidity which we see reported in the daily papers is the *relative humidity*; that is, the ratio between the amount of water that the air contains and what it would contain if it were saturated. For example, if the humidity is 60%, that means that the air contains 60% of the amount of water that it would contain at that temperature if the air were saturated. The amount of water vapor in the air is measured by means of the wet- and dry-bulb thermometers, or *hygrometer*. This instrument really consists of two thermometers, the bulb of one being kept moist by a porous wick. The evaporation of water from the cloth around the wick cools the mercury, and the more rapid the rate of evaporation, the more rapidly the mercury will fall and the greater will be the difference between the two thermometer readings.

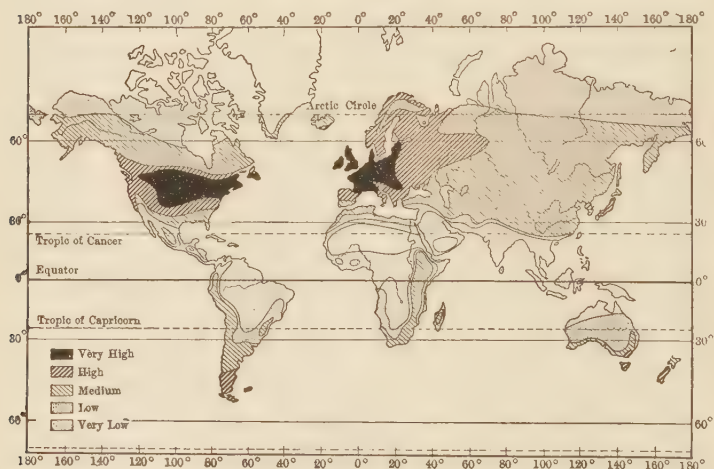
Humidity in buildings. — Every one of us knows how uncomfortable a crowded auditorium becomes after we have been in it for a short time. The room seems suddenly

hot, but, as a matter of fact, if we were to take the temperature, we should not find it very much higher. We should, however, find a very great rise in humidity, caused by the loss of water from the breath and through the skin of the people in the room. The ventilation of public buildings is an important matter, as is the ventilation of our schoolrooms. Heated rooms are sometimes made more comfortable by the use of electric fans, which produce a circulation of air. In winter higher humidity in the rooms of a house or factory is desirable, for with more moisture in the air one can be comfortable at a lower temperature and one is much less likely to take cold upon going out of doors. A relative humidity of 60% to 70% is desirable in the house. Humidity is important in many industries. In weaving cotton cloth, the threads break more easily in dry, cold air than in warm, moist air, hence a high humidity is maintained artificially in the weaving rooms. On the other hand, drying clothes and making hay require a dry atmosphere.



Wet- and dry-bulb thermometers and hair hygrometer: useful instruments in determining humidity.

Health influenced by climate. — An interesting study has been made by Huntington on what he calls the climatic energy in this country compared with the death rate in different parts of the country. His maps on climatic energy have been worked out from a study of the civilization and achievements of people in all parts of the world, and based on the climate of that part of the world in which they live. The map for the United States shows that cer-



The distribution of human energy on the basis of climate. (After Huntington.)

tain states to the east and north enjoy a somewhat more favorable climate than other states. He shows also that the death rate in areas that have the greatest climatic energy is less than in those states where the climatic energy is not so great. While many factors probably enter into the formation of these figures, we cannot escape the conclusion that climate does play a very important part in our success or failure in life, and in making a location a favorable place in which to live. It is also a well-known

fact that there are more epidemic diseases among people in tropical climates than in the temperate. This is due in part to lack of sanitary measures.

What is an ideal climate? — From all that we have just seen, we are now ready to give some sort of answer to this question. The most favorable climate must certainly not be very cold or very hot. It must have some rainfall, at least thirty inches a year, to be ideal. We should be located near enough to large bodies of water so that we may benefit from their moderation of temperature and humidity. On the other hand, a high humidity, often found along bodies of water in summer, is uncomfortable. Above all, our climate should have a large number of sunny days, so that health may be an asset to our community. Study the temperature, rainfall, and other climatic conditions of your community to see how it scores.

SCORE CARD. CLIMATE AND WEATHER OF MY COMMUNITY

	PER- FECT SCORE	MY SCORE
Extremes in yearly range of temperature not below 0° nor above 95° (20), below -15° or above 100° (15), below -25° or above 102° (10), below -35° or above 105° (5)	20	
Sunshine 60% of days (20), 50% (16), 40% (12), 30% (10), 20% (8). Consult sunshine map, page 277	20	
Rainfall 30 to 60 inches (10), 20 to 30 or over 60 inches (5)	10	
No tornadoes (10), infrequent (2), frequent (0)	10	
No danger from lightning (10), infrequent (2), frequent (0)	10	
No long periods of severe heat or severe cold (10), infrequent (5), frequent (0)	10	
Freedom from damage by floods or excessive rains (10), floods very infrequent (5), floods frequent (0)	10	
Freedom from excessive heat, drought, high winds, or early frosts (10), crops infrequently damaged (5), frequently damaged (0)	10	
TOTAL	100	

REFERENCE BOOKS

- Atmospheric Phenomena.* General Science Quarterly, Salem, Mass. January, 1921.
- Brigham and McFarlane, *Essentials of Geography, Book II.* American Book Company.
- Caldwell and Eikenberry, *General Science.* Ginn and Company.
- Cox and Arrington, *The Weather and Climate of Chicago.* University of Chicago Press.
- Gilbert and Brigham, *Introduction to Physical Geography.* D. Appleton and Company.
- Gregory-Keller-Bishop, *Physical and Commercial Geography.* (For teachers.) Ginn and Company.
- Harrington, *About the Weather.* D. Appleton and Company.
- Houston, *The Wonder Book of the Atmosphere.* Stokes Company.
- Hunter, *A Civic Biology.* American Book Company.
- Hunter, *Laboratory Problems in Civic Biology.* American Book Company.
- Huntington, *Civilization and Climate.* (For teachers.) Yale University Press.
- Jameson, *Weather Series for the Amateur.* Taylor Instrument Company, Rochester, N. Y.
- Lake, *General Science.* Silver, Burdett and Company.
- Rolt-Wheeler, *The Boy with the United States Weather Men.* Lothrop, Lee, and Shepard Company.
- Smith and Jewett, *Introduction to the Study of Science.* The Macmillan Company.
- Snyder, *Everyday Science.* Allyn and Bacon.
- Trafton, *Science of Home and Community.* The Macmillan Company.
- Ward, *Climate.* (For teachers.) G. P. Putnam's Sons.
- Whitman, *Lightning.* November, 1916. General Science Quarterly, Salem, Massachusetts.

PART IX. WATER AND ITS PLACE IN THE LIFE OF THE COMMUNITY

CHAPTER XIX

WATER AND ITS RELATION TO COMMUNITY WELFARE

Problems. — 1. *To learn the needs for water of food-producing plants.*

2. *To learn the part water plays in tearing down and building up land.*

3. *To understand what is meant by water power.*

4. *To learn about devices for utilizing water power.*

5. *To learn about the forest regions of the United States.*

6. *To learn how arid land can be watered.*

Suggested projects. — 34. A study of local water power.

35. A survey of the community trees.

Importance of water. Have you ever considered the part water plays in our daily life? We have already seen that it is an important factor in determining climate and that by its erosive force it has carved out river beds and provided favorable places for communities. Some communities are dependent upon water power for their growth. Others owe their importance to the contour of the land which provides opportunity for easy rail facilities to the navigable rivers, which in turn offer means of cheap com-

munication. Still others depend on deep harbors, which are valuable for commerce. The cities shown in the accompanying diagram all owe their importance to some of the factors mentioned above.

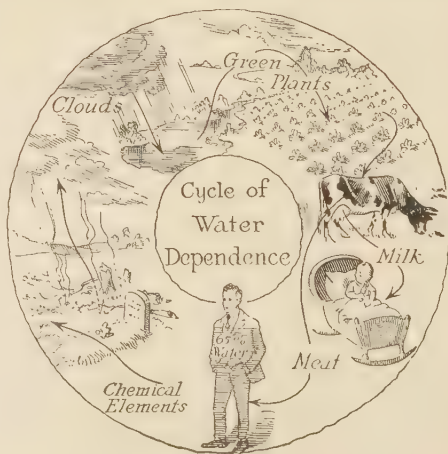


What factors favor these cities?

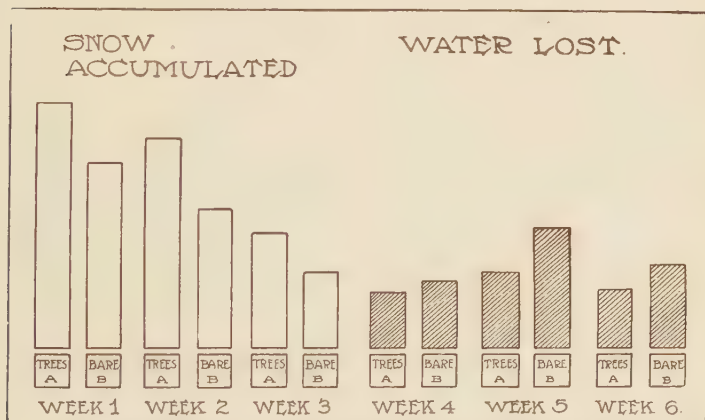
But more than this, water plays a most important part that we sometimes forget. It makes plant life possible on the earth. Our forests, with their many uses, our fiber crops, our medicinal plants and many others you could mention are dependent upon water. From green plants we get our food, for most of the beasts

of the field depend upon plants and need water to drink.

Water forms a very large part of the composition of the bodies of plants and animals. Man himself is composed of about 65% water. Water, as we shall see in the following chapters, plays an all-important part in our lives.



Why water is held in the earth.— It has been explained already that in some localities the earth acts like a sponge, in allowing water to soak into its depths. We know that in a wooded country water disappears under the covering of mosses and decaying vegetation, while in a region in which the trees have been removed water flows away much more readily.



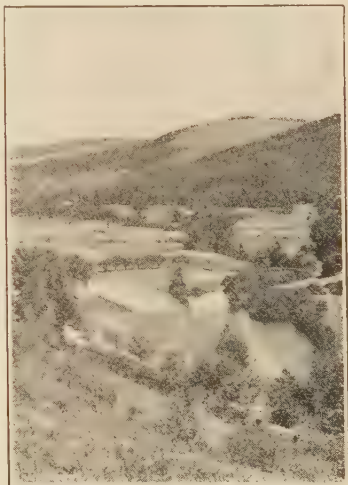
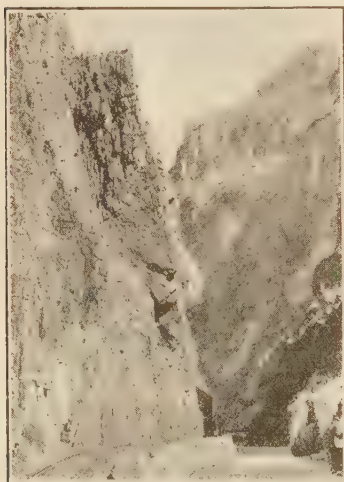
In the White Mountains the United States Geological Survey compared two areas, each about 5 mi. sq. Area A was covered with trees. Area B had no trees. A weekly estimate was made, first of the amount of snow that accumulated on the two plots, then later of the amount of water that was lost. What is the conclusion?

The experiment of the United States Geological Survey, shown in the diagram on this page, proves that forests prevent floods by retaining the rainfall. Usually rivers which rise in hilly districts where the forests have been cut down receive the rainfall all at once instead of gradually. The result is a freshet or flood. In this way the covering on the earth's surface of trees and other vegetation is of much importance in the regulation of water supplies.

Demonstration Experiment. — To see which kinds of soils hold water best.

Materials: Three straight lamp chimneys. Cheesecloth. Sandy gravel, sand, and clay. Three glasses.

Method: Tie two thicknesses of cheesecloth over one end of each of the chimneys. Fill each to the same level ($\frac{3}{4}$ full) with the three kinds of soil respectively, which should be dry. Support each of these over a glass tumbler. Pour the same amount of water into each chimney. After all three of the soils have become saturated and all the water



Contrast the steep walls of the cañon with the well-rounded hills which result from long ages of erosion.

has run through that will, measure the water that has passed through.

Results: Which soil holds the most water? Which the least?

Application: What are the advantages and disadvantages of each of these types of soils?

The erosive force of water has been described already. We have seen its work in digging deep valleys and cañons. It is safe to say that all the valleys we have seen or are likely to see have been made by the wash of running water. A deep valley with steep, sloping sides is a young valley and is still in process of being cut out and deepened

by the action of water. These valleys are seen to best advantage in the wonderful cañons of the West. The Colorado River, for example, runs for a thousand miles through a gorge which it has cut from one to several thousand feet through solid rock. Such a gorge is of very recent origin in geological times. On the other hand, the rounded hills of New England are much older, and have required a longer period of time in being formed.

Experiment. — To show the solvent action of water containing carbon dioxide.

Water containing carbon dioxide will dissolve certain mineral substances. This carbon dioxide comes either from mineral springs or from the oxidation of organic materials in the soil. When such ground water flows through rocks which are easily soluble, such as limestone, it becomes loaded with mineral matter and is called hard. Such water is not usable in boilers of manufacturing plants. For this reason many communities in the Central West, which depend upon deep wells for their water supply, are forced either to soften their water artificially or else have their manufacturing plants move to other more favorably located cities.



Marengo Cave.

Water may build rock also. Certain soluble compounds, when brought together in water, unite to form new in-

soluble compounds. If water bearing such materials filters down into the cracks between rocks, precipitation of these new compounds may take place, and veins of mineral matter may be formed. Precipitation may result also from cooling, from evaporation, and from the loss of some gaseous constituent, as carbon dioxide. In some of these ways veins of many valuable minerals have been formed, such as veins of gold, silver, and copper which form an extremely valuable asset to the community.

Water as a land builder. — Water, through its erosive action, has become an important factor in the formation



Map of Rhode Island superimposed on the delta of the Mississippi.

of new land. Sand and particles of soil are torn out from the banks of streams and rivers and carried long distances in rapidly flowing water to be deposited ultimately as deltas where the current of the river is stopped by reaching the ocean level. The delta formed at the mouth of the Mississippi at present con-

tains almost as much land as three times the area of Connecticut and is growing into the Gulf of Mexico at the rate of one-sixth of a mile a year. All the area occupied by Louisiana, and a large part of Alabama, Arkansas, Florida, Mississippi, and Texas, was once a part of the Gulf of Mexico, these states having been formed largely by material which was carried down by

the rivers flowing from the north. The great glacier which covered all the northern part of the United States at one time must have furnished an immense amount of water and billions of tons of soil to the rivers which aided in the formation of these states.

What is water power? — No one who has ever seen a mountain stream after a heavy rain could fail to notice that the water was doing work. Big stones and small ones, tree trunks and logs, all tear their way down stream, borne on by the force of the rushing water. If you have ever rowed a boat against a current, you know the water pushes you back, and when you turn, carries the boat down stream easily. Water power is force exerted by the water and can be measured in terms of work accomplished. For example, Niagara River pours over the falls every hour 22,000,000 tons of water, which, falling a little over 160 feet, gives rise to over 5,000,000 horse power of energy. Let us remember that *work*, is the measure of resistance overcome through space. The unit of work is the *foot pound*. A foot pound of work is done when we lift a pound weight one foot or when a pound falls one foot, or when we move a body a distance of one foot horizontally by using a pound force in overcoming friction or other resistance. Power is the *rate* at which work is performed. For example, a stream which can turn a given wheel 100 times a minute has more power than one which turns it 50 times a minute.

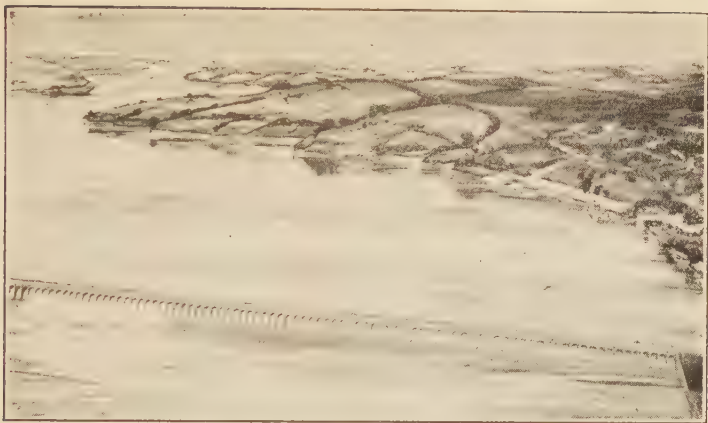
Experiment.— To measure the horse power of a motor.

What is horse power? — The term “horse power” came into use in England before the time of steam. It was the amount of power based on the amount of coal a horse could raise in a second. This amount is the unit of horse power and is 550 foot pounds of work a second.



Keokuk dam across the Mississippi, showing power house and locks. It supplies St. Louis, 144 miles away, with electricity.

The utilization of water power. — Any intelligent boy or girl must remember that our public supplies of coal, oil, and natural gas are exhaustible, and will become exhausted at our growing rate of consumption, possibly within a few centuries. Water power will then become a very important source of energy for running railways, lighting cities, and operating machinery in manufacturing plants and homes, as it is to a limited extent to-day. Water provides the cheapest kind of power. So long as we have the sun, evaporation will take place, rain will fall, and streams will flow. The building of a dam and the installation of machinery as an initial expense is large, but the running expenses are small. All of us know of Niagara Falls with its 500,000 horse power development, of the Keokuk dam on the Mississippi with its 150,000 horse power turbines, and of the great Norwegian water power plants with over 500,000 horse power already in use.



Keokuk is the greatest power dam in the world, being capable of developing over 300,000 horse power. It is nearly a mile in length.

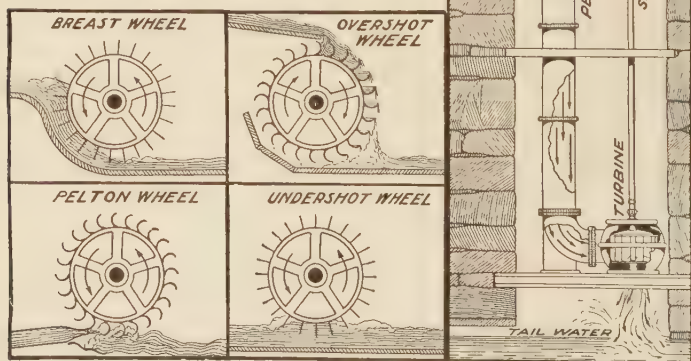
The manufacturer's problem. — One of the first problems a manufacturer has to consider when he locates on a stream, is how he can make the best use of the water power at that particular point. Several factors have to be taken into consideration: the fall at that point, the amount of water available, and the steadiness of the flow.

The first and second factors together determine the type of water wheel to be used, while the third factor determines the size of the dam to be built, for no manufacturing project can run without power at all seasons.

Water wheels. — Several types of water wheels are used. The *undershot wheel* is most useful where a large amount of water is available but where there is little fall.

A much more efficient undershot wheel, used when there is a strong flow and but little volume of water, is the

Pelton wheel, so called after the inventor. Here water pressure is the important factor. The *overshot wheel* is useful where the fall is not very great and the amount of water available is not large. The water pours into a series of box-like troughs, and the weight of the water turns the wheel. This wheel is very efficient, losing only 10% to 20% of the water power. The *breast wheel* is like the undershot wheel, but since water has some "fall" it develops more power. To-day most of the power utilized from water is produced by the turbine. Here a number of thin blades, set



Types of water wheels.

at an angle, catch the force of the water. The wheel is located usually at the bottom of a pit or shaft. The water, coming down a pipe from above, enters the turbine case from one side and flows through the turbine which

revolves in a horizontal plane on a vertical axis. (See figure on page 304.) As much as 90% of the energy of the water is utilized by this kind of wheel.

The relation of water power to the growth of communities. — No boy or girl who has studied commercial geography can fail to remember the numerous towns and



A deforested hillside.

U.S. Forest Service.

cities in our eastern and middle Atlantic states which have come into existence along streams and rivers. The chief reason for the location of such places is the presence of water. Either water has been used directly for power, as in the case of the Merrimack River in New England, or as arteries of commerce, as in the case of the scores of manufacturing towns in Pennsylvania, where the rivers serve to float barges and other boats loaded with raw materials and fuel. In many instances the commercial

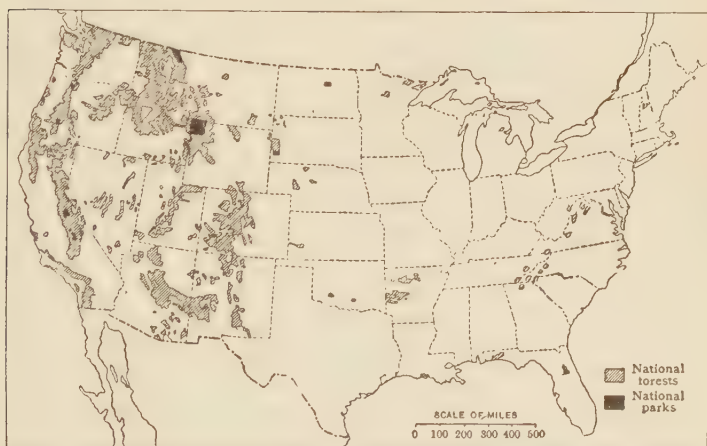
importance of such cities depends upon the forests which regulate the water supply. Many parts of the world, especially China, Europe, and some sections of our own country, are now showing the results of cutting off the forests. Have you ever stopped to think what might happen to some of our cities located on or at the mouths of great rivers if the water supply in these rivers could not be regulated?

It is estimated that in New England, where water power has been so large a factor in determining the location of many important industries, only about half of the available water power is used. That the amount used is not larger, is due partly to the fact that the flow of water varies so much during the year. Frequently the rivers are more than twice as large in the spring as they are in late summer. Great impounding reservoirs are proposed, which will hold a supply of water in reserve until it is needed. It is expected that sometime in the future, great centrally located power houses will give New England more heat, light, and power from these rivers which are only partly harnessed now.

The community's need for tree protection. — Wood in the form of fuel or as building material frequently gives an asset which makes a community of commercial importance. But of almost incalculable importance is the protection rendered by forests to our source of water supply. In addition forests give a breeding place to countless insect-eating birds, the friends of the farmer. Trees beautify our city streets and make our parks places of rest and recreation. Every means possible should be taken for their protection.

Fortunately the country is waking up to the need of forest protection. Wise laws have been passed, making

certain areas into forest reserves and National Parks, many of which are open to the public. These areas are guarded by trained forest rangers, whose duty it is to protect the trees, supervise any cutting that may take place there, and above all to prevent forest fires. Among all the enemies of the forest, insect pests and destructive fungi included, fire is the most destructive. Carelessness



This map shows where our national forests and parks are located.

of smokers, hunters, and small boys, causes a large number of fires, while burning brush and sparks from engines are responsible for others. "A single tree will make a million matches but a single match can destroy a million trees." It usually takes half a century or longer for a tree to attain its full growth.

Effects of differences in water supply. — A traveler going overland from New York to San Francisco passes through very different kinds of territory. In the East,

308 RELATION OF WATER TO COMMUNITY WELFARE

he sees rounded hills covered with forests, broad, sloping valleys, beautiful streams, fertile farms, manufacturing cities and towns, and a large number of small lakes and ponds. Beyond comes the Middle West with its fertile acres of corn and grain, its rolling and almost level plains.



Compare the bare desert region with the plant-bearing, well-watered region.

Then after he has journeyed westward over the prairies he comes to the mountains with their rugged peaks often whitened with snow, and the road winds up through deep gorges cut by water through the mountain sides. Perhaps he obtains glimpses of some of the wonderful irri-

gation projects which have caused the "desert valleys to blossom as a rose." Farther west he passes great stretches of desert, some of which may never become useful for agriculture because of their distance from water; and near the Pacific Coast, he finds a land of vegetation once more. Any one taking such a trip cannot help but be impressed with the relation of plant life to water



Harvesting wheat.

supply. While light and favorable temperatures are necessary factors for the growth of plants, water plays an even more important part in their lives.

Conditions favorable for some crops. — As we take our trip across the continent we cannot fail to notice that our country is favored with crops of great variety. In the South and the far Southwest we have some tropical fruits and fiber plants; we have the apples of Oregon

and of New York, we have the sugar cane of the South, and we have the wheat and the corn of the great Northwest. It is evident that variation in climate as well as differences in water supply is responsible for these diverse kinds of crops. Wheat, for example, needs a cool, moist growing season, and a warm ripening season; corn needs



Swamp, before and after draining.

a longer and warmer growing season than wheat, and is very dependent upon water supply. Oats as well as barley and rye are more hardy and take a damp and cool climate. Rice is a water-loving plant, and thrives best in a warm, wet climate. Grass, the king among crops in this country because of its importance as food for animals, seems to thrive with a moderate supply of water and can even withstand considerable drought. In the case of some of

the sugar-producing plants, we find that sugar cane requires a deep, moist, and well-drained soil and a long hot season, but the sugar beet grows in a cooler climate, and requires much less water.

The reclamation of swamp areas. — Some of the richest land in the United States is now under water. The United States Government Reclamation Service estimates that there are one hundred million acres of undrained swamp land in the United States that will some day be available for use. This land, when drained, becomes useful for intensive farming because of the great amount of decayed organic matter in the soil. Some of this land has already been reclaimed, and many thousand acres are being added yearly by the Reclamation Service. In the Everglades of Florida, parts of which have been drained already, some of the great drainage canals serve as a means for transportation.

Experiment. — To show the effect of a surface mulch.

Dry farming. — A study of the map showing rainfall in the United States on page 247 shows that a very large part of our western states do not get enough rain to support crops. The rain that does fall is lost soon by direct evaporation from the ground. To overcome this difficulty farmers practice what is known as dry farming. To do this they must first plow the ground deep so that when the rain comes the ground will be ready to soak it up and retain it. Then the surface layer of the ground must be constantly worked and turned over to form a *surface mulch*. This is done by making a layer of very finely pulverized soil on top. Ground water travels upward from particle to particle by capillary action. Compact

soil allows water to pass rapidly by capillary action to the surface, where it escapes by evaporation. Breaking up the soil so that the particles lie loosely together prevents this action and makes it possible to raise crops requiring little moisture such as alfalfa, hard wheat, kafir corn and millet. In some places farmers can only grow one crop every other year because of the small amount of

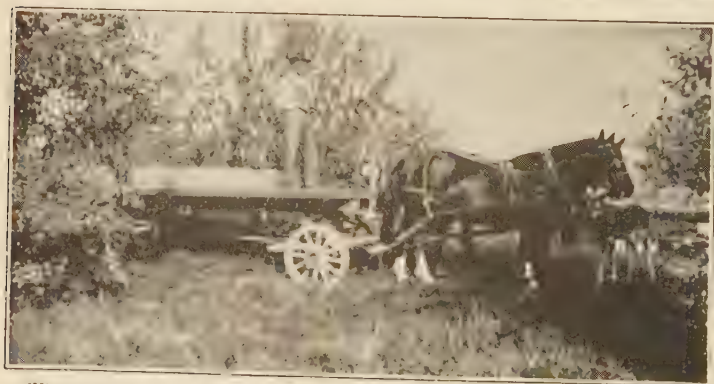


Roosevelt Dam conserves billions of gallons of water for irrigation purposes.

water. In such cases, the farmer keeps half of his land under cultivation, and the other half covered with a surface mulch so as to allow it to accumulate water.

Irrigation and irrigation projects.—Irrigation has been practiced from the early times of civilized man. If water is not present in soil, it may be brought to it by means of canals. It has been found that there is much rich alluvial soil in the West which would be valuable if it could be supplied with water.

of canals to the surrounding desert country. Some of these canals are over a hundred miles in length, and have many small branches, which in turn lead into ditches, feeding the land with the much needed water. As a result



What irrigation does for a dry region. Above: first day on the homestead.
Below: same place six years later.

of irrigation, land becomes worth from sixty to three hundred dollars an acre. Through irrigation large crops of wheat and garden truck are raised. Wonderful orchards, especially of apples, have been developed in Colorado

and Oregon. Because of the intensive farming practiced, people live close together and have all the comforts of community life, for these irrigation projects furnish water power, which in turn is changed into electricity and used for manufacturing purposes. Irrigation has become one of the greatest boons the West has ever had.

SCORE CARD. RELATION OF WATER TO ECONOMIC LIFE OF COMMUNITY

Score two of the four, making a possible total of 100 points for your community.

		PER- FECT SCORE	MY SCORE
1. WATER POWER	Over 200,000 horse power produced in my community (15), over 100,000 (10), over 10,000 (3) All water power utilized by the community (10), partly (5), none (0) Impounding dams for regulation and storage of water (5) Many manufactories as result of water power (10), few (5), none (0) Electric light and power cheap as result of water power (10), moderate (7), expensive (3)	50	
2. AGRICUL- TURE	Farms well watered (10), moderately (5), poor (2) Farm soil never lost as result of floods (5), soil some- times lost (3), often (0) Snow protecting land in winter (5) Farms workable from Apr. 1-Nov. 1 (10), May 1- Oct. 1 (7), June 1-Sept. 1 (5) Rainfall abundant (10), moderate (7), scant (2) Reclamation of all swamp areas (5) Irrigation of all dry areas (5)	50	
3. FORESTS	Protection afforded against forest fires (10) Protected against overcutting (10) Forest reserve areas or large forests near (10) Forestry practiced by lumbering companies (10) River watershed protected by forests (10), few trees (5), none (0)	50	
4. COMMUNITY TREES	Public parks with many trees (10) Tree protection in streets practiced: Spraying (2½), pruning (2½), screens (2½), tree surgery (2½) Tree planting practiced (7) Arbor Day observed (3) Many trees on city streets (10), few (5), none (0) Many trees in community home grounds (10), few (5), none (0)	50	
	TOTAL	100	

REFERENCE BOOKS

- Articles on *Trees in City Streets*. American City Magazine.
- Barber, *First Course in General Science*. Henry Holt and Company.
- Bowman, *Forest Physiography*. John Wiley and Company.
- Brigham and McFarlane, *Essentials of Geography*. American Book Company.
- Bruncken, *North American Forests and Forestry*. (For teachers.) G. P. Putnam's Sons.
- Caldwell and Eikenberry, *General Science*. Ginn and Company.
- Chamberlain, *North America*. (Work of the Reclamation Service.) The Macmillan Company.
- Daniels, *Electric Light and Power from Small Streams*. Yearbook, 1918, U.S. Department of Agriculture.
- Dryer, *Elementary Economic Geography*. American Book Company.
- Fenno, *Care of Trees in Street, Lawn, and Park*. Henry Holt and Company.
- Fisher, *Resources and Industries of the United States*. Ginn and Company.
- Gilbert and Brigham, *Introduction to Physical Geography*. D. Appleton and Company.
- Hunter, *A Civic Biology*. American Book Company.
- Hunter, *Laboratory Problems in Civic Biology*. American Book Company.
- Lynde, *Home Water Works*. Sturgis and Walton Company.
- Pinchot, *Primer of Forestry*. Farmers' Bulletin 173, U.S. Dept. of Agriculture.
- Rogers, *Trees Worth Knowing*. Doubleday, Page and Company.
- Roosevelt and others, *Forest Preservation and National Property*.
Forestry Circular 25, U.S. Dept. of Agriculture.
Yearbooks U.S. Dept. of Agriculture 1895 to Date. Look for articles on forestry and work of the forests.
- Trafton, *Bird Friends*. (For teachers.) Houghton Mifflin Company.
- U.S. Dept. of Agriculture. *Reclamation Service Publications*.

CHAPTER XX

THE COMMUNITY WATER SUPPLY

Problems. — 1. *To learn what constitutes a pure drinking water.*

2. *To learn what are the community needs of water.*

3. *To learn how a community may obtain a supply of safe water.*

4. *To learn how water is purified by filtration and by chemical treatment.*

5. *To learn the proper care of a public water supply.*

Suggested project. — 36. To investigate and report on the public water supply of my own community.

Water supplies. — It goes without saying that a town or city could not exist without drinking water. The people of ancient Greece and Rome, unable to obtain water on the spot where they built their cities, went to great expense to build long aqueducts to bring it to their homes.

When the Pilgrims landed at Plymouth, they looked for a suitable place to settle. An old journal tells us that Captain Miles Standish and his party "marched into ye land and found there cornfields and little running brooks, a place fit for a situation." So here, with the "little running brooks" for their water supply, they founded their first community.

The modern community, no less than those of ancient times, has gone to very great expense and labor to obtain pure water.

What is pure drinking water?— We have already learned that water can and often does contain other matter than that which falls from the clouds as rain. Rain water, before it comes in contact with anything on the earth, is practically *pure* water. But water may be perfectly good to drink and contain mineral matter in solution. Such water is *pure* as far as necessary for drinking purposes. Water which contains organic matter, especially if there is much decaying material present, is *not* pure. Simply because it contains germs which might be harmful to the human body.

Experiment. — To show the danger of judging the purity of water by its appearance.

Sources of water. — The household which takes its water from a well or spring has one problem. But the community which must provide water not only for drinking but also for washing, street cleaning, manufacturing, and fire protection has another. It is evident that a single spring would not meet the demands of even a small community. And even a number of artesian wells rarely provide water in sufficient quantity for all the needs of a town. In addition artesian well water, although containing no harmful germs, usually does contain certain salts which make it difficult to use in manufacturing plants. Therefore, for such uses the city must depend upon surface water, streams, or rivers, the banks of which are often used for human habitation. Surface water, no matter how careful people may be, often receives some drainage

containing the body waste of animals and man. Our problem is to find out how such water coming from streams, rivers or lakes may be made safe to drink.

Sewage disposal into rivers. — Sewage consists of about one part of organic matter to one thousand parts of water. In rapidly flowing rivers a small amount of sewage may be carried off without harm, since the bacteria of decay, adhering to the stones in the rivers, act on the solid wastes

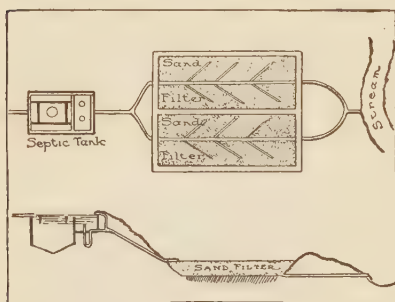


Chicago drainage canal.

and break them down quickly into harmless liquid substances. But in a large city, sewage disposal is a big problem, because of the great volume of sewage, its odor, and the possibility of the spread of disease from it. The city of New York empties daily 450,000,000 gallons of sewage into the rivers surrounding it; thus Manhattan Island is bathed in dilute sewage. Chicago, a few years ago, discharged its sewage into Lake Michigan. At that time a large number of typhoid cases existed in the city,

and it was discovered that some of the sewage found its way to the intake of the city water supply in the lake about two miles from the shore. Chicago then spent \$40,000,000 to build a drainage canal which connected the Chicago River with the Des Plaines River. Through this canal the water of Lake Michigan flowed into the Mississippi, carrying the sewage of Chicago with it. The city of St. Louis brought suit against the city of Chicago, attempt-

ing to prevent the use of this drainage canal, but the verdict given was "no cause for action" because it was found that Mississippi water about St. Louis contained no more germs than it did before the canal was built. This shows that



Septic tank and sand filters used to purify sewage.

sewage, while flowing long distances, becomes purified. Harmful germs are gradually killed off by the action of sunlight and oxygen and from lack of food.

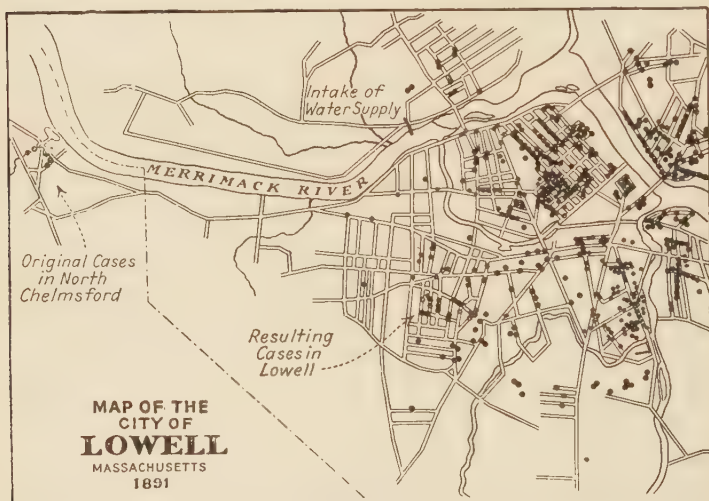
Other methods of sewage disposal. — Where sewage cannot be run into a body of water the problem is not so easy. One method is to pass the sewage to a disposal plant where by means of septic tanks, filter beds, mechanical and chemical treatment, the sewage can be transformed into comparatively harmless and odorless material. In some small cities, abroad and in this country, sewage is passed without treatment to sandy areas and used to fertilize the soil. The soil thus treated is used for farming purposes by the city. This, however, is not advisable for

long periods of time as the soil becomes "sour" and unfit for cultivation.

Problems of water supply for communities. — The need of an abundant as well as a pure water supply in a large community is most important. We know, at the present time, that many cities are forced to take their supply of drinking water from sources which are bound to be contaminated. Take, for example, Buffalo or Cleveland, which take their water supply from the lake on which they are situated, and into which the sewers of these cities flow. Or, take Philadelphia or Pittsburgh, which must draw their supply from rivers which are greatly contaminated by sewage from the many small cities and towns located above the point from which they take their water. A third type of city might be New York or Los Angeles, which have no near source of water supply and must, in order to get an abundant supply of pure water, tap sources far distant from the city. For each of these three types of cities the problem of obtaining a pure water supply is quite different.

River water supply. — In 1891 Allen Hazen, and a number of experts on water supply, made a study of a typhoid epidemic which occurred in the cities of Lowell and Lawrence, Massachusetts. The city of Lowell took its water supply, *without filtering* it, from the Merrimack River at a point a few miles above the city. Typhoid fever appeared in the little hamlet of North Chelmsford, a few miles above Lowell. About two weeks later an extensive epidemic of typhoid broke out in Lowell. Almost a month later a similar epidemic, although not so great in magnitude, occurred in Lawrence, about ten miles farther down the Merrimack River. A little thought will

show us what happened. The typhoid germs from the sewage of North Chelmsford passed into the water pipes of Lowell and infected the people who drank the water. The germs in turn were discharged into the sewers of Lowell and carried down the river to Lawrence. Fortunately for the latter city, typhoid germs are killed rather



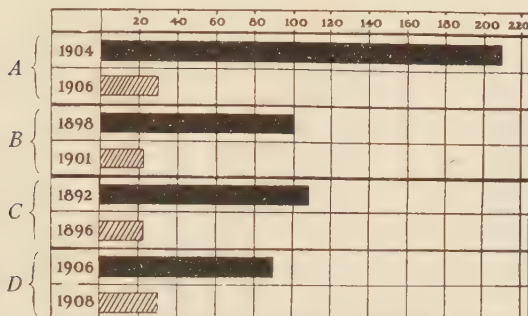
In 1891 Lowell was supplied with unfiltered water from the Merrimack River. Why is such a supply dangerous? Each black dot represents a case of typhoid fever.

easily, and the exposure of the billions of germs to the air and sunlight as they passed down the river was sufficient to destroy great numbers of them. But still enough remained to cause the great outbreak of typhoid in Lawrence. This episode has been repeated with variations in almost every city or town which has taken its water unfiltered from streams into which sewage passes.

Filters and filter beds. — The experiments of Hazen showed beyond doubt that filters of sand take out enough

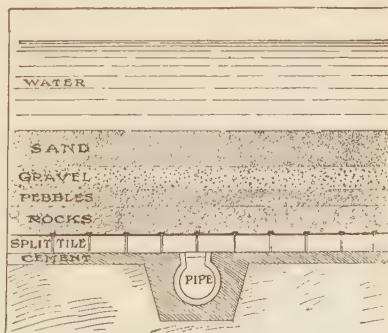
germs from contaminated water to make it fairly safe to drink.

A study of the accompanying diagram and picture will



Cases of typhoid per 100,000 inhabitants before filtering water supply (solid) and after (shaded) in A, Watertown, N. Y.; B, Albany, N. Y.; C, Lawrence, Mass.; D, Cincinnati, Ohio. What is the effect of filtering the water supply?

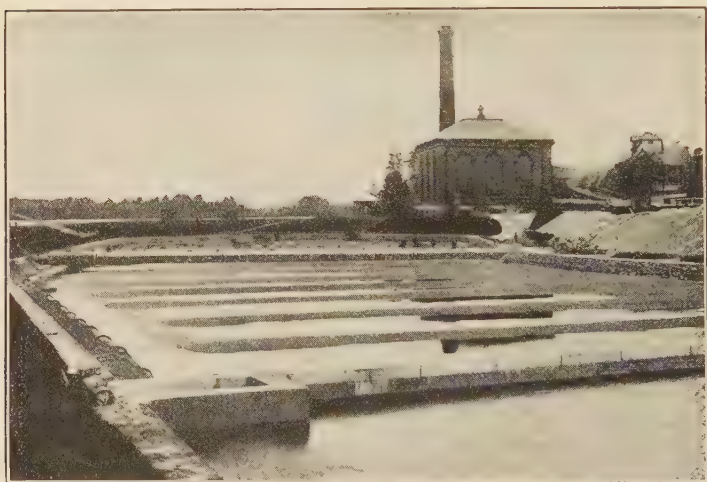
give you some idea of how a filter bed is made. You will notice that the bed consists of small stones, gravel, coarse sand, and fine sand in layers. If these layers are of sufficient depth to allow the water to trickle through very slowly, they will take out about 98% of the germs, which of course, are left behind in the fine sand. Consequently, in order to make a filter plant fit for service a number of beds must be planned



Structure of a filter bed.

so that certain of them may be put out of use every few weeks, the sand removed, sterilized, and the filter bed

thoroughly cleaned. The installation of filter beds is very expensive, but they more than pay for themselves in the saving of human lives and health.



A modern filtration plant.

Three sections of sand filter beds are shown: the farthest one being cleaned, the middle one draining, and the one in the foreground now filling.

Demonstration Experiment. — To see what impurities can be removed from water by filtration.

Materials: Funnel. Fine sand. Powdered animal charcoal. Test tubes. Filter paper. Impure water containing a sulphate in solution, suspended matter (mud), and cochineal (coloring matter). Barium chloride solution.

Method: (1) Fill the filter paper in the funnel nearly full of clean fine sand. Pour some of the muddy water upon it and catch the filtrate in a test tube.

(2) Boil a little of the solution with the powdered charcoal. Pour it upon a filter paper placed in a funnel. Pour back the first spoonful that filters through, then catch the filtrate in a test tube.

(3) Test the filtrate in each case for a sulphate by adding barium chloride solution. If it turns milky, the sulphate is present.

Results and Conclusion: What are the results in each case?

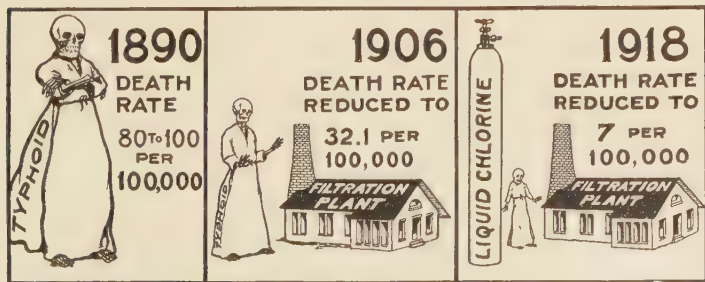
Formulate a statement summing up the value of filtration in purifying water.

Application: What are a few of the reasons why many cities filter public water supply? Is there any other reason which is not illustrated by this experiment?

Use of reservoirs. — A reservoir is an additional protection to water supplies. Disease germs remaining in a large body of water for even a relatively short period of time lose their vitality and die. This is due to the fact that there is no vegetable or animal matter upon which they can feed. Air and sunlight also assist in the destruction. Therefore, any large reservoir holding a reserve supply of water aids in destroying the germs.



A comparatively pure water supply.



Notice how deaths from typhoid diminished upon the introduction of the filtration plant and diminished again when the use of chlorine was introduced.

Use of chemicals. — Most water supplies which are not reasonably pure are protected nowadays, in addition to other means, by the use of chemicals. Bleaching powder and liquid chlorine are used very successfully, and kill all harmful germs.

A modern city water supply. — The city of New York offers an excellent example of a modern project for the supply of pure water to a large city. New York found



The Ashokan dam, seen from below; beyond it, hidden from view, is the great reservoir of the Catskill water supply of New York.

many years ago that it must go a distance of about 50 miles from the city to get a supply in sufficient quantity that was pure. In 1842 it began using water from the Croton River, some 40 miles from the city. Here a great dam had been built across the river, an aqueduct constructed, receiving reservoirs built, and a large supply of pure water was obtained. In 1890 this system was enlarged again, but the city continued to grow, and as its needs increased it became evident that a supply of pure

water could be obtained only at a greater distance from the city. So large tracts of land, 900 square miles in all, were acquired in the Catskill Mountains. Great aqueducts extending over 127 miles in length were built, and the huge Ashokan reservoir was constructed on the Esopus River. The cost of this tremendous undertaking amounted to over \$200,000,000 at the time of its completion; but it now provides New York with a supply of almost 1,000,000,000 gallons of water daily. The present available supply should be sufficient for a city of 8,000,000 inhabitants, allowing 125 gallons a day for each person.

Pressure necessary. — In the case of the water supply of Los Angeles, where the water comes in a main nearly



Distribution of water from a reservoir or a standpipe.

250 miles from an elevation in the Sierra Nevada, the pressure, or head of water, as it is called, is obtained through gravity. In case the water supply is drawn from lakes or rivers near at hand it becomes necessary for the city to install a pumping plant. Water is pumped into a reservoir or standpipe situated on an elevation above the city; it then flows by gravity through the pipes of the city.

Experiment. — To illustrate gravity distribution of a water supply.

Protection of water supplies. — Where a city obtains its water supply either from a small river or from a mountain lake, it becomes necessary to protect the watershed

or surface of the land through which the water may flow into this river or lake.

It therefore becomes necessary to remove wherever possible the homes of all people in this area which drains into the water supply. Wherever this is impossible, as is the case in the watershed of the city of New York, there must be strict regulations to prevent pollution. New York maintains a sanitary police force, one of whose duties it is to prevent any violations of the laws which protect the water. Every boy or girl who wishes to be a good citizen should remember, when camping or picnicking near any public water supply, that the utmost care for the protection of the water is necessary.

Why this chapter was written. — If high school boys and girls could realize their obligations, as well as the benefits which are given them by their communities, they would become better citizens. What are some of these obligations which involve the care of public water supplies?

First. We should never injure public property. Cost of repairs is a large item of expense in the keeping up of public property of all kinds, and this is equally true in the upkeep of hydrants, water pipes, and reservoirs.

Second. Care of public watersheds. Damage done by careless picnickers may be much greater than one imagines. Always clean up rubbish and decaying material. Use only public toilets in parks or near watersheds.

Third. Report to the health authorities the breaking of any rules of sanitation about which you know.

Fourth. If fishing or camping is done, the utmost care must be observed not to pollute the water.

Fifth. Care in the use of water at home. Leaks should

be reported at once and stopped. Leaking faucets are a source of very great expense to the city and often to the private owner, where the water is metered. Water should be used carefully during the dry seasons, as we cannot afford to be selfish in the use of any public commodity.

Sixth. Personal hygiene. Avoid drinking water that you do not know about. Boil all drinking water if it is suspicious. Learn the source of your own water supply, its strong and its weak points. Beware of drinking from open wells in visits to the country.

How to score my own city water supply.—For this purpose direct inquiry from the city department of water supply may result in obtaining first-hand information and pamphlets which will give you the desired information. Visit the city reservoirs and filter beds; the city pumping station, if there is one, and best of all, the source of your community water supply. In making out the score card which follows on page 330 observe these directions.

REFERENCE BOOKS

- Barber, *First Course in General Science*. Henry Holt and Company.
 Broadhurst, *Home and Community Hygiene*. (For teachers.) J. B. Lippincott Company.
 Brown, *Health in Home and Town*. D. C. Heath and Company.
 Coleman, *The People's Health*. The Macmillan Company.
 Farmers' Bulletin 478, *How to Prevent Typhoid Fever*. U. S. Dept. of Agriculture.
 Glenn, *The Water Supply Systems of Oakland, Cleveland, Muskogee, Cincinnati, and New York*. General Science Quarterly. Vol. 6, Nos. 3 and 4; Vol. 7, Nos. 1, 2, and 4.
 Godfrey, *The Health of the City*. Houghton Mifflin Company.
 Hazen, *Clean Water and How to Get It*. (For teachers.) John Wiley and Sons.
 Hughes, *Community Civics*. Allyn and Bacon.
 Hough and Sedgwick, *The Human Mechanism, Part II*. Ginn and Company.
 Mason, *Water Supply*. (For teachers.) John Wiley and Sons.
 O'Shea and Kellogg, *Health and Cleanliness*. The Macmillan Company.
 Smith and Jewett, *Introduction to the Study of Science*. The Macmillan Company.
 Trafton, *Science of Home and Community*. The Macmillan Company.

SCORE CARD. COMMUNITY WATER SUPPLY

		PER- FECT SCORE	My SCORE
SOURCE	Water from pure source, well protected, public excluded (20) Water from river or small lake, where public is allowed, but where no sewers empty (10) Water from bodies of water in which sewers empty (3)	20	
SAFE WATER	No epidemics were ever traced to the water (10) Diseases have on rare occasions been traced to the water (5) Diseases frequently traced to water (0)	10	
SAFEGUARDS	Water is tested frequently and is filtered or chemically treated, and filter is cleaned regularly (10) Water is rarely tested but is filtered (5) Water is rarely tested and is not filtered (0)	10	
DESIRABLE WATER	Water is soft, odorless, tasteless, colorless (20) Water is hard (10) Water is hard, and has color, taste, or odor (3)	20	
ADEQUATE SUPPLY	Water under good "head" at all times and no restrictions imposed on its use in dry season (20) Good pressure but use restricted during drought (10) Low pressure at times and restricted use (3)	20	
PUBLIC CONVENIENCE	City maintains public fountains, wading ponds, drinking troughs for animals, and bubble fountains for people (10), three of these (5), none (0)	10	
COST	Rate where unmetered not over \$10.00 a year for family of five, or cost where metered not average over \$10.00 a year for family of five (10), not over \$14.00 (5), over \$14.00 (0)	10	
	TOTAL	100	

PART X. HOW THE COMMUNITY CARES FOR ITS CITIZENS

CHAPTER XXI

HOW THE COMMUNITY PROVIDES FOR PROPER FOOD

Problems. — 1. *To learn the steps taken by government, state, and town in insuring a pure food supply.*

2. *To learn the dangers from impure milk and how to avoid them.*

3. *To learn the advantages and the disadvantages of cold storage.*

4. *To learn the essential requirements to make a store where food is sold sanitary.*

5. *To learn what is meant by the "Pure Food and Drug Act."*

6. *To understand some of the dangers from patent medicines and drugs.*

Suggested projects. — 37. To investigate the subject of pure foods in my community.

38. A study of the "Patent Medicine" situation.

Common supplies placed under the control of the community. — As a community grows in size, it becomes necessary to safeguard the health of its citizens by the control of all supplies that are used in common. Care

must be taken of the water and milk supplies and the sale of various kinds of foodstuffs supervised and regulated, for health depends upon pure food and water. Various departments of a city government have been organized to protect the health and the rights of its citizens — of these the board of health should be the most important.

How our meats are protected. — All over the United States the government has placed federal inspectors whose business it is to see that all animals which are killed for meat are in good condition. These inspectors work in the great slaughterhouses and packing houses, examining animals and meat in over 244 cities and in over 3000 different large establishments. Pork is examined for a parasite called trichina and beef for tuberculosis, while the buildings in which the work is done are regulated according to certain sanitary standards. The clothes of the workers, the appliances for sterilizing buckets, knives, tanks, and other parts of the plant, and the control of pests are all regulated by law. In many cities the slaughterhouses are required to be rat proof, and screened against flies, and all refuse must be disposed of at once. Is there a slaughterhouse in your town? If so, is it sanitary? You should make a trip to it and see if conditions are favorable, and then report on the visit as a home project.

Means of protecting food supplies. — It is only recently that communities have begun to take care of their food supplies. People have been educated gradually until now most communities have the proper facilities for caring for foods on sale. Some communities, however, are not as careful as they should be and although laws are made they are not kept. This is an opportunity for you to do your duty as a young citizen. Are there farms near where

you live that produce dirty milk? Are there stores in which milk is sold in cans unprotected from flies and dirt? Are your food supplies fresh when they are bought and used before they become old? Do you read the labels on your canned goods and preserves, and do you understand what these labels mean? If you are to be a really useful member of your community, you should not only know the pure food laws and their meaning, but you should do your part also in helping to enforce these laws.

Demonstration Experiment. — To determine the condition of our milk supply.

I. Test for clean milk.

Materials: Funnel. Absorbent cotton. Milk.

Method: Wet the cotton with water and place it in the funnel. Filter a quart of milk through it. Make two 2-inch circles in your notebook.

Result: If dirt is found on the cotton, record this by darkening the second of the two circles with pencil dots until it presents about the same appearance as the cotton filter. If desired, a clean cotton and the dried cotton holding the dirt may be pasted on the circles for a record.

II. How to keep milk.

Materials: Three half-pint milk bottles. A pail or kettle large enough to hold one of the bottles. Thermometer. 1 pint of fresh milk.



Bottling milk for delivery.

Method: Fill each bottle full of fresh milk. Close the bottles with plugs of absorbent cotton. Set one bottle of milk on a strip of wood in a pail or a kettle. Add a pint of water and heat gradually to 145° F. Keep at this temperature 30 minutes. Remove the bottle of milk; cool it quickly by running water or setting it in cold water.

Place a second bottle of milk out of doors when the temperature is considerably below freezing. In warm weather pack it in salt and ice. Keep it below the freezing point for 4 hours. Label these two bottles and leave at about 70° F. for two days. Keep the third bottle in a refrigerator at 50° F. or under.

Since the souring of milk is caused by bacteria the degree of sourness is an indication of the amount of bacterial action.

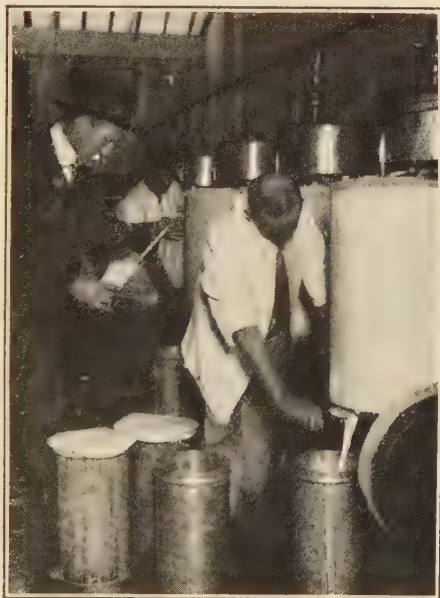
Result and Conclusion: After two days remove a teaspoonful of milk from each bottle. Test sourness by taste. What effect does pasteurization have on the growth of bacteria in milk? Effect of freezing? Of keeping at a low temperature? Which is more effective in checking the growth of bacteria, pasteurization or freezing?

Application: How may milk be freed from dirt? What is a good way for you to take care of the milk after it has been delivered to you? What would be an indication of its freshness?

What is pure milk? — Milk is one of the most important human foods, but it is also one of the most easily contaminated. Milk, as soon as it comes from the cow, even under the most sanitary conditions, contains some bacteria. Milk is usually classified according to purity, in three grades. Grade A milk must come from cows which are examined frequently by inspectors and are found to be free from disease. When this milk is delivered raw (which means not pasteurized), it must not contain more than 10,000 bacteria per cubic centimeter (c. c.) To obtain such a condition the barns, the dairy and the milk cans must be kept clean, and the workers must be free from dirt and disease. Grade A milk which is pasteurized must be produced by cows free from disease also, the general sanitary conditions must be good, and the bacterial count must not be over 200,000 per c. c. before pasturi-

zation, and not more than 30,000 per c. c. upon delivery to the consumer. Grade B milk, which is the kind usually bought in large cities, when sold raw must not contain more than 300,000 bacteria per c. c. and when pasteurized must not contain more than 1,000,000 per c. c. before pasteurization and not more than 100,000 per c. c. at the time of delivery. Grade C milk should be used for cooking purposes only, as the bacteria are too numerous to allow it to be used in other ways with safety.

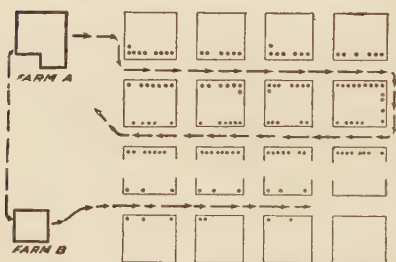
How pure milk is obtained. — The purest milk comes from cows which



Inspection of milk.

are healthy and kept in clean surroundings, and yet this milk might be contaminated by a dirty or sick milker and his germs sent in the milk to cause disease in the city where it is delivered. Care must be exercised therefore at every point. The milk must be cooled immediately after it is taken from the cow, put into clean containers and kept at a temperature not higher than 50° F. until it is used. In most cities, the big milk companies pasteurize their milk on a large scale by passing

it over pipes filled with steam. This raises the milk to a temperature of about 178° F. for less than a minute. This method of pasteurization (the flash method) is not as good as the slower method of heating the milk to 145° for thirty minutes, but it kills the harmful bacteria in the milk.



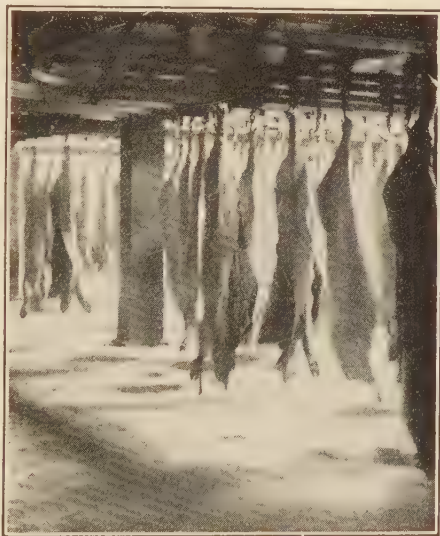
A case of typhoid exists at farm A, which has a large milk route. Farm B has a small milk route and supplies some milk to A. The cans from B are washed at A and returned to B. Each black dot represents a case of typhoid caused by infected milk. How do you account for the cases along B's route?

Why impure milk is dangerous. — As has been mentioned above one of the chief reasons for exercising great care in the production of milk is the fact that it frequently carries certain disease germs, such as

typhoid, diphtheria, scarlet fever, tuberculosis, and septic sore throat, while diarrhea, dysentery, whooping cough, and measles are probably carried by it also. The germ which causes tuberculosis in cows does not appear to be the same as that which occurs in adults, but over 30% of tuberculosis in children under five years of age is of the same kind as that found in cows.

Cold storage and its relation to foods. — Refrigeration is most important for milk, because it prevents the growth of bacteria which are present in it. Other fresh foods keep better at a low temperature for the same reason. Cold storage plants, are considered a necessity for large communities, as meats, fish, and other foods may be kept in them from several weeks to several months, or even longer without spoiling. While storing food at a freezing temperature changes its flavor, yet if the food is

fresh when it is put in cold storage and if it is used soon after it is taken out, no serious harm has been done to it. Foods kept in cold storage for a long time are softened so that bacteria grow rapidly in them when placed in a warmer temperature. Sometimes fish and meats are put into cold storage after the bacteria have begun to spoil them. Naturally such foods would be unfit to eat at any time and cold storage does not improve them. On the whole, cold storage is a boon to modern society, for it enables us to have fresh vegetables, eggs, and other perishable foods at times when they could not be obtained otherwise.



Meat kept in cold storage.

The sale of meats, milk, and groceries. — One of the most important functions of the board of health is to see that the stores in which milk, meats, fruits, and groceries are sold are clean and sanitary. In many communities the law provides that certain kinds of perishable goods must be kept under glass or well screened. This is particularly important in the summer season. Can you see a reason for this? Does the grocer with whom you deal have a clean and well-ventilated shop? Are the receptacles

containing flour, sugar, etc., always kept covered? Are vegetables and fruits exposed so that people may handle

CARE OF FOODS IN A STORE

KEPT CLOSED UNDER GLASS	SHIELDED FROM FLIES, DUST, AND HANDS	IN THE RE- FRIGERATOR	ELEVATED 12 INCHES ABOVE FLOOR	MAY BE KEPT ON FLOOR
bread cakes candy cheese opened fruits pastry pies radishes shelled nuts watermelon (cut)	berries celery cherries crackers dates figs grapes lettuce peaches pears prunes	butter cottage cheese dried currants eggs fresh fish fresh meats milk mincemeat (fresh) oysters raisins	artichoke cabbages cantaloupe cauliflower cranberries dried fruits dried meats grapefruit lemons oranges plums pickled food spinach	canned goods carrots cucumbers nuts (whole) onions peas potatoes pumpkins squash turnips watermelon

them and flies and other vermin touch them? If so, you should not patronize the place. Foods which have no natural protection should be kept covered when offered for sale and at all other times to prevent contamination and the spread of disease germs. Suppose a man with tuberculosis should cough on the fruits, vegetables, or into an open can of milk. What would prevent you from innocently carrying home those germs and taking them into your own body? An ounce of prevention is worth several pounds of cure in this case.

The Pure Food and Drug Act and how it operates. — Although Congress doubtless thought the Pure Food and Drug Act embodied good laws when it passed in 1906, the results are not as satisfactory in all respects as was hoped.

This act defines an *adulteration* as: anything which is added to food to cheapen it; anything mixed with food to reduce or injure its quality; any valuable part taken away from the food; the mixing of colored or stained

material with food to conceal damaged or inferior material; the addition of poisonous materials and the use of any decayed animal or vegetable substances which are unfit to eat. This act provides also for the punishment of any one who is detected practicing any of these adulterations. This act has prevented the adulteration of foods to any great extent where the civic authorities are active, but if the board of health of a town or city is not alert, foods kept in bulk may be adulterated easily by dishonest manufacturers or storekeepers. The act *does* make it necessary for any firm putting up food in containers to state on a label exactly what the food contains. For example, if your grocer keeps cheap jellies, jams, marmalades, or flavoring substances, you may find labels on the bottles or cans stating that artificial coloring, a preservative and 10% glucose are used. The federal Food and Drug Act exercises no control over the sale of foods and medicines prepared and sold in the *same* state. The law applies only to *interstate* commerce. The state laws should apply to preparations manufactured and sold within the state, but unfortunately some states are very lax in this matter. What are the food and drug laws in your state? Are they well enforced?

Cheap candies are adulterated often by coloring with poor dyes. They are sweetened frequently with saccharin and made with white clay or glue and covered sometimes with shellac mixed with iron rust or lamp-black. Different fruit flavors are made synthetically out of coal-tar products. There is danger also from soda fountains where saccharin is used in place of sugar and many fruit flavorings are made of coal-tar products. In addition to this, the glasses at the soda fountains and other

public places are often not well washed and the danger of the transfer of bacteria from one person to another is very great. We should patronize places which use individual paraffin paper cups.

Experiment. — To see if the "butter" used at home is real butter, oleomargarine, or renovated butter.

Some common adulterations. — Many adulterations are met with every day and are not at all harmful. Oleomargarine made with coloring matter in it is sometimes



An inspector purchasing a sample product for testing.

unlawfully sold as butter. As a matter of fact, oleomargarine is perfectly wholesome, as are also nut butters, nut oils, cottonseed oil, and other substitutes. Cottonseed oil is used frequently as an adulterant or substitute for the more expensive olive oil. Molasses, honey, and maple sirup are

often adulterated with glucose or corn sirup. Corn sirup is a good food, but it is cheaper than the materials for which it is substituted and is therefore an adulterant. Cheap grades of condensed milk may have sugar added to them to take the place of nutrients which were removed from the milk. Coffee, tea, and cocoa are fre-

quently adulterated by the addition of such materials as cornstarch, old tea leaves, chicory, cocoa shells, and other cheap products. We have spoken of candy having saccharin, clay, glue, and other materials added to it. Some foods may have adulterants of a harmful nature. Chemicals are used to change the color of meats, such as saltpeter, which brings back the red color to partly decayed meat, and alum and other poisonous compounds may be found in flour.

Chicory can easily be detected in coffee by simply adding the ground material slowly to a glass of water. Chicory sinks at once. Starch in coffee can be found easily through the iodine test. Saccharin is soluble in chloroform, while sugar is not. Glucose added to honey can be detected by the addition of a few drops of a weak solution of potassium iodide. If the color disappears from the honey, glucose is present.

Experiment. — To test jelly, jam, or ice cream for glucose and starch.

Some harmful preservatives. — In some respects the use of preservatives is also very harmful. Food is not injured when preserved by means of heat or cold, but if chemical substances are used to prevent bacteria already present from causing further decay, the result is dangerous. Many foods contain, under the Pure Food and Drug Act, small quantities of alum, borax, benzoate of soda, benzoic acid, and certain sulphites. These are probably harmless to any one taking a small quantity of the food containing them, yet they are not substances we wish to have added to food, and indicate that they were used to check decay because the material was not fresh when put into the cans or bottles.

Patent medicines and the Pure Food and Drug Act. —

The American people are probably the greatest consumers of "patent medicines" of any people in the world, but they are gradually becoming educated, as a result of the Pure Food and Drug Act, to realize that many patent medicines are harmful rather than beneficial. It is not often that one should venture to take medicine except under the advice of a physician, for the wrong medicine



The amounts of alcohol in some liquors and in some patent medicines.

A, beer, 5%; B, claret, 8%; C, champagne, 9%; D, whiskey, 50%; E, well-known sarsaparilla, 18%; F, G, H, much-advertised nerve tonics, 14%, 18%, 12%; I, another much-advertised sarsaparilla, 18%; J, a well-known tonic, 14%; K, L, bitters, 20%, 25% alcohol.

would do much more harm than none at all and the body is able to cure itself if given a chance. The chief advantage of the Act with reference to patent medicines lies in the fact that the labels on the bottles must not tell untruths, as they have done frequently in the past, because the Act prohibits fraudulent statements on the package or bottle. When a medicine is advertised to cure everything, it is evident that it is a fraud. Such labels have been changed to substitute the word "remedy" for the word "cure."

There are eleven drugs which must be declared on the

label if present in the medicine. They are: alcohol, morphine, opium, cocaine, heroin, alpha and beta-eucaine, chloroform, cannabis indica, chloral hydrate, and acetanilid. Other drugs, even poisons, like arsenic and strychnin, need not be disclosed under the present law.

Drugs and their dangers. — Patent medicines might be divided into several groups, according to their composition and uses. The most dangerous of them contain habit-forming drugs, of which we shall speak in a moment. Another type of patent medicine includes the so-called cough sirups which are used to soothe the suffering of people who have tuberculosis. Still another type of drug is said to cure people who have incurable diseases. Such drugs are sold usually to people in the last stages of disease and most frequently these people are harmed instead of helped. Drugs are dangerous to use except in the hands of expert physicians. Last of all are the medical fakes, "cures" to make thin people fat and fat people thin, instruments to cure deafness, or to bring about vitality to weak people.

Most headache cures are harmful and even dangerous. They usually contain phenacetin, acetanilid, chloral, morphine, or some other drug which depresses the heart, causing it to beat more slowly. They also deaden the sensation of pain. Such drugs do not *cure* headaches, they simply cover up the real cause of the trouble and tend to make the user addicted to the drug. Moreover, if a person has a weak heart, these drugs may slow down its action until death follows. No one should use headache powders except by the advice of a physician.

Habit-forming drugs. — The basis of many patent medicines which are used as home remedies is alcohol.

Some of these contain over 30% of alcohol, and people have become intoxicated with patent medicines when they could not obtain liquor otherwise. Too often such medicines have been the cause of the formation of an alcoholic habit. The person taking the medicine containing alcohol feels better temporarily because of the deadening effect of it and craves more of the same drug. As a result, he soon becomes addicted to the alcohol habit. Other habit-forming drugs contain opium, morphine, or heroin, the users of which soon become "dope fiends."

Medical fakes. — Under such a heading would be placed the so-called *cure-alls* for incurable diseases, such as cancer cures, consumptive cures, the obesity cures, the cures for deafness and epilepsy, and many others. Many of these are pure and simple fakes. Cures for over-fatness, for example, have been found to be made of such materials as cream of tartar and baking soda, sweetened and colored pink. It is perfectly evident that such materials would not make a fat person thin. Tuberculosis can be cured only by treatment and not by drugs. Cancer is curable only in its early stages and so far as known not by drugs at all. Some pieces of apparatus sold to make deaf people hear are absolutely valueless, and if used may harm the middle ear.

Lack of knowledge decreases the effectiveness of the Pure Food and Drug Act. — The Pure Food and Drug Act permits the use of certain adulterants provided they are plainly marked on the label of the container. But the majority of people are not educated in these matters so that they know what is harmful and what is harmless. The only way for us to learn how to make use of the Pure Food and Drug Act properly is to get some reliable infor-

mation as to what constitutes harmful preservatives and what materials are harmful in medicines. Then if we take the trouble to read the labels which the Pure Food and Drug Act causes to be placed on the containers, we can sometimes avoid taking poisons into the body.

The American Medical Association has published many pamphlets on medical frauds which will suggest material for several interesting reports before the class.

Visit some good-natured druggist and note what medicines have recorded on the labels any of the eleven drugs mentioned on page 343. Learn if you can, from your druggist or physician, other prepared medicines which contain harmful or poisonous drugs not indicated by the label. Collect newspaper advertisements of medicines and compare the claims made in these advertisements with those on the labels. Above all, talk over the subject of adulterants and patent medicines with your father and mother and with other people interested in it.

And finally, after you have the facts, score up that part of your community in which you live, with reference to the points suggested in the score card on the community care of food which is printed on the following page.

REFERENCE BOOKS

- Abel, *The Care of Food in the Home*. Farmers' Bulletin 375, U.S. Dept. of Agriculture.
- Adams, *The Great American Fraud*. American Medical Ass'n, Chicago.
- Allen, *Civics and Health*. (For teachers.) Ginn and Company.
- Broadhurst, *Home and Community Hygiene*. J. B. Lippincott Company.
- Bulletin 56, *Milk and Its Relation to Public Health*. U.S. Public Health Service.
- Cramp, *The Nostrum and the Public Health*. General Science Quarterly, May, 1921.
- Fisher and Fish, *How to Live*. Funk and Wagnalls Company.
- Forbes, *What Not to Do for a Headache*. World's Work, June, 1910.
- Hodgdon, *Elementary General Science*. Hinds, Hayden, and Eldredge.
- Hughes, *Community Civics*. Allyn and Bacon.

- Johnson, *The Drug Clerk a Poor Doctor*. World's Work, July, 1910.
 Jordan, *Food Poisoning*. (For teachers.) University of Chicago Press.
 Kebler, et al., *Harmfulness of Headache Mixtures*. Farmers' Bulletin 377.
Medical Fakes and Fakers. American Medical Ass'n, Chicago.
Nostrums and Quackery. American Medical Ass'n, Chicago.
 Olson, *Pure Foods*. Ginn and Company.
 Overton, *General Hygiene*. American Book Company.
 Russell, *The Danger in the Drug Store*. Pearson's Magazine, June, 1910.
 Richards, *The Cost of Cleanliness*. (For teachers.) John Wiley and Sons.
 Rosenau, *The Milk Question*. (For teachers.) Houghton Mifflin Company.
 Wiley, *Foods and Their Adulteration*. (For teachers.) P. Blakiston's Son and Company.
 Wing, *Milk and Its Products*. The Macmillan Company.
 Wood, *Sanitation Practically Applied*. (For teachers.) John Wiley and Sons.
 Ziegler and Jacquette, *Our Community*. J. C. Winston Company.

SCORE CARD. COMMUNITY CARE OF FOOD

		TOTAL SCORE	MY SCORE
MILK INSPECTION	Milk inspected at farm where produced (2) Milk inspected in transit to city (2) Milk inspected in bottling establishment (2) Milk inspected at point of sale (2) Tubercular tested cows furnish all of supply (8) Laws with reference to typhoid carriers enforced (5) Grading of milk sold based on standard of American Medical Association (see pp. 334, 335) and sold as graded; all milk below grade "A" pasteurized; no dipped milk sold (9)	30	
FOOD INSPECTION	Regular inspection of slaughterhouses and meats (5) Regular inspection of cold storage plants (2) No cold storage goods unfit for public use sold (3) All bakeries regularly inspected (3) Modern baking plant in community (1) Foods in store kept according to schedule, p. 338 (3) All foods on push-carts covered (3) Butcher shops inspected regularly and free from flies and offal (5) Shellfish and fish supplies safeguarded and inspected (5) All persons handling foods free from disease, restaurants clean and inviting (5) Soda fountains, individual and sanitary drinking cups (5) Regular inspection of weights and measures (5)	45	
PURE FOOD AND DRUG ACT	No adulterated candy sold (5), some (2), much (0) No medical fakes sold (10), some (4), many (0) No headache cures sold without prescription (10), some (4), many (0)	25	
	TOTAL	100	

CHAPTER XXII

HOW THE COMMUNITY FIGHTS DISEASE

Problems. — 1. *To learn about the board of health.*

2. *To learn the best methods for disposing of community wastes.*

3. *To learn how we may fight contagious diseases.*

4. *To understand the problems connected with flies in a community.*

5. *To understand the relation of malaria and yellow fever to mosquitoes.*

6. *To learn the best ways to fight flies and mosquitoes.*

7. *To learn how some other insects carry diseases.*

Suggested projects. — 39. *To exterminate flies from my home and community.*

40. *To make a study of the disposal of wastes in my community.*

How the community fights disease. — We find that when people live together in communities many of those rights which were personal when living at a distance from neighbors become rights to be shared with others. In consequence laws have to be made, and a police force organized to make people respect and obey the laws. Different city departments are also formed to care for the cleaning of streets, the disposal of garbage and other wastes, the maintenance of the water supply, the organization and care of schools, and most important of all, the

health department. Too many people are careless, some are selfish, and others are not well informed, so that they innocently spread contagious diseases about which they know nothing. The health department is of great importance because it assists in the formation of laws under which it can quarantine or isolate people who have contagious diseases and protect other people from getting the germs. Moreover, the department of health is expected



Modern hospital ward.

to look after the welfare of all sick people who are unable to pay for the services of a doctor. In New York, Chicago, Cleveland, Cincinnati, St. Louis, and many other cities not only does the health department provide hospitals to care for almost every kind of disease, but it also provides ambulances in which to carry the sick. In case of an accident on the city streets or in buildings, an ambulance takes the person to a city hospital, where city doctors and nurses are in attendance. These doctors and nurses are paid out of the city budget. The community, if it is a

large one, has special sanatoriums also for people who have tuberculosis; it has homes for the feeble-minded, for the insane, and for those who are incurably sick; and it provides shelter for the needy.

How the streets are kept clean. — Most of us are familiar with the “White Wings” seen in many of our city streets. Their work is to clean the streets with hand brooms, brushes and machines; to flood the streets, usually at night, and to assist in the collection of the sweepings from the streets. Most large communities own street-sweeping machines which are far more efficient and do more work than a number of men. The sweepings are collected in carts and then disposed of. It has been found that very many street cleaners are subject to tuberculosis. This indicates the need for the enforcement of a law against spitting in the streets. We know that such laws are rarely observed.



“White wings.”

Demonstration Experiment. — To compare the wet and dry methods of street cleaning.

Materials: Petri dishes. Sterile agar.

Method: If possible, select two localities where streets are cleaned differently: one by dry sweeping and the other by wet cleaning. Expose a petri dish to the air in each locality for five minutes. Put the dishes away in a dark warm place for three or four days. Instead of the two places cleaned as above, the experiment may be carried out by exposing one dish in the street after a rain and the other dish in dry weather while the street is being swept.

Result and Conclusion: Compare the number of bacteria colonies which develop in the two dishes. Explain.

Application: Which method of street cleaning would you advise for your neighborhood?

Disposal of ashes and garbage. — Garbage may be defined as scraps from the kitchen, including waste animal



Vacuum cleaning in the street.

and vegetable matter, which is unfit for use. Rubbish includes tin cans, broken glass and crockery, waste paper and rags, and ashes that are the remains from fuel. Dr. Rosenau of Harvard has estimated that the waste in New York amounts to one ton a person in a year. This means that over 5,000,000 tons of waste is collected annually in this city alone. Papers and rags are manufactured into paper; the iron, tin, and solder from old cans may be used over again, and organic matter is made into fertilizers.

In small communities garbage may be burned, buried, or, better yet, fed to the pigs; but in large communities these methods are impossible and the garbage must be carefully placed in covered pails, collected and removed, usually in metal carts, to some distance from the city where it is safe to dispose of it. One of the best methods is that of burning.

Many cities now own their own incinerating plants. In New York and in some other cities garbage is taken to a reduction plant where bones and other dry wastes are removed by mean of machinery. The organic waste is then heated from eight to ten hours



The old and the new cart for collecting garbage.

under a high steam pressure, and treated with chemicals; the fats are extracted from it, and the solid matter remaining is pressed into flat cakes and sold for fertilizers. Fats taken from the garbage by this process are used in the production of soap and perfumery, and all of the waste

matter is made use of in some way or other. Thus materials which in olden times made life in a community unpleasant and unhealthful are now disposed of quickly and without offensive odors. Disposal plants are now being worked so efficiently that they more than pay for themselves.

Quarantine. — All of you who have seen a blasting gang at work may have noticed that just before the blast



Two kinds of warnings which are to save lives.

is sent off one or two of the members go out into the street, waving red flags and calling out loudly, "Fire! Fire!"

By means of a placard which is red or made conspicuous in some other way the health department warns people that there is a contagious disease in a particular house. The health officer in a community has the right to keep people confined who are sick with certain catching or contagious diseases such as measles, diphtheria, sore throat, and whooping cough, and to placard the houses in which they are, that all may know of the danger from disease there. Restrictions on a sick person or one suspected of being infected is known as quarantine.

Some of the ways in which contagious diseases are spread. — We have seen already that germs grow rapidly in moist, warm places where there is food for them. When this warm, moist place is the throat or nose, it is apparent that the easiest way to scatter them is by coughing or by spitting. In the winter when you are talking with your schoolmates, stand between them and the light and you will notice that as they talk, little droplets fly out of their

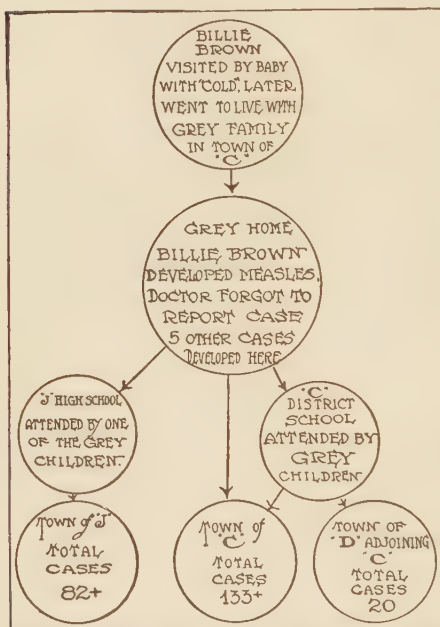
mouths and pass into the air in a constant spray. This spray reaches from eighteen inches to three feet from the person who talks. It is quite evident that any one who has germs in his throat or mouth could easily pass them out with these little droplets to some one who stood within the three-foot limit. Kissing and putting into the mouth things which have been in the mouths of those having contagious diseases are other methods of getting an infection.



Always cough or sneeze into your handkerchief. Why?

The incubation period of a disease. — Practically every child's disease begins with sneezing, running at the nose, and a slight cough and fever, so it is evident that if a child has any or all of these symptoms, he should be kept at home. The period from the time that the disease germ enters and begins to grow in a person's body until the time that the symptoms of the disease are evident is called the *incubation period*. During this period of time the disease germs are growing in the body but not making themselves known because the poisons which they give off have not been formed in large enough quantities seriously to affect the person's system. This incubation period varies considerably for different diseases. For mumps, it is 15 to 22 days; for whooping cough, 14 days; for chicken pox, 11 to 22 days; for measles, 8 to 15 days; while for diphtheria, it is only from 1 to 5 days. After one has been exposed to a contagious disease, if the symptoms do not develop within the time of the incubation period, we may know he has escaped.

How we may help to fight contagious diseases. — The first and biggest thing that any person can do to help fight contagious diseases is to be *unselfish*. One should be honest, intelligent, and observe health rules as well. If a



According to Health News, N. Y., the failure of a doctor to report the first case of measles resulted in its spread until there were 235 cases.

contagious disease does appear in our home, we must see to it that the case is strictly quarantined from other members of the family and that all the dishes, clothes, bed clothes, and everything else used by the patient are carefully disinfected with some germicide like chloride of lime, mercury bichloride, lysol, carbolic acid, or boiling water.

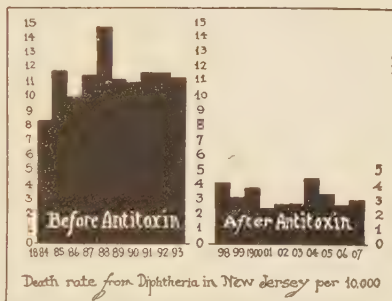
Immunity: natural and acquired. —

Occasionally as we well know, some one who has been exposed to a contagious disease does not take the disease and we say he is *immune*. Some persons are more susceptible to diseases than others and this may be caused by fatigue, overwork, or by misusing the body in any way, either through the use of drugs or of alcohol, so that the blood is not able to resist the toxins of the bacteria and there is no natural immunity to the disease.

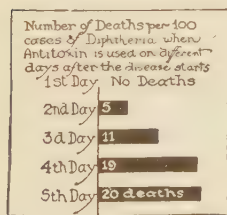
It is possible for the body to acquire immunity against diseases through the use of *antitoxins* and *vaccines* also. Both antitoxins and vaccines are furnished free by the boards of health of most communities, and as a study of the diagrams show, they are very important factors in the prevention of certain diseases.

Use of antitoxin for diphtheria. — Perhaps the most widely known antitoxin is

that used for the prevention of diphtheria. An antitoxin is a substance which is produced by the living cells of the body under the stimulation of a toxin or poison. Each



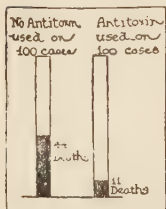
Antitoxin has greatly reduced the death rate from diphtheria.



Antitoxin must be used in the early stages of diphtheria to be of value.

antitoxin will neutralize or destroy only the toxin which caused it to come into existence, and so in the preparation of antitoxin for diphtheria, they use horses into whose blood has been introduced a certain amount of diphtheria toxin. This causes the cells of the horse to manufacture antitoxins which get into the liquid part of its blood. After two or three months the blood of this horse has a large amount of antitoxin in it and it is drawn off and allowed to clot. The serum or liquid part contains all of the antitoxin, and after preparation with the greatest care it is put up in small tubes to be

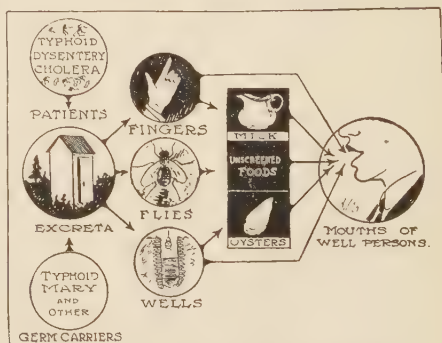
injected into the body either of a person who has diphtheria or of one who has been exposed to the disease. As a glance at the diagram shows, this antitoxin is most efficient when used in the early stages of the disease.



Typhoid vaccine has greatly reduced the danger from typhoid.

Vaccination. — Another form of acquired immunity is obtained through the use of vaccines. In the case of vaccination for typhoid, the dead typhoid germs are injected into the body where their toxins stimulate the healthy cells to *produce* substances which cause the body to become immune. In the use of an antitoxin, the substances *already prepared* are injected

into the blood where they neutralize the products formed by the disease germs. In your community the board of health prepares and gives out antitoxins and vaccines. These substances are the most important we have to combat diseases, and every person should coöperate with the board of health to have them used.



What is the story told by this diagram?

Flies and disease. — Some infectious diseases, especially typhoid and diarrhea, are undoubtedly carried by flies as a glance at the accompanying diagram shows. The flies get the disease germs on their feet and leave them in milk or on food and then the germs get into the food tube where they

cause trouble. Among the diseases which may be spread in this way are tuberculosis, bubonic plague, anthrax, and smallpox. Flies are undoubtedly a very important factor in the health of a community during the hot weather. Let us see how we may best go to work to rid our community of this menace to health and comfort.

How we may help to fight the fly. — Any one may

“swat the fly” all day long in September and make very little impression upon the myriads of flies which have come into existence since early May. A few flies remain alive over the winter, hiding in cracks or crannies in our houses; early in the spring they come out and lay their first batch of eggs. Practically 95 % of all house flies breed in horse manure and during warm weather their eggs develop into adult flies within two weeks after they are



Black indicates deaths; shaded, the fly season.

laid. It is evident that if all material containing the eggs of flies breeding in the early spring could be removed, the first generation of flies would not come into existence; but if this is not done, as soon as the flies begin to breed they multiply with tremendous rapidity.

Experiment. — To work out the life history of the fly.

A single fly may lay at one time from one hundred to two hundred eggs. Professor Hodge of the University of Florida estimates that from May 1 to August 1 a pair of flies might produce 5,746,670,500 flies or enough to fill a school building of 26 rooms of average size. Flytraps and poisons used in May and June will prevent many flies from ever getting an opportunity to start this chain of descendants. Why not start an early crusade against flies in *your* home? In order to protect ourselves from disease we should screen all out-of-door privies, keep the garbage cans covered, and scald them at least twice a week during the hot weather. Rubbish and manure heaps should not be tolerated.



The four stages in the life history of the fly.

How a community fights flies. — After all, the fly nuisance is largely in the hands of the community. A town can be kept free from flies by united effort. Every boy and girl who reads these paragraphs ought to help to arouse public sentiment so that every individual who from selfishness or ignorance allows a manure heap to become a menace to the health of the community will realize that he is not doing a fair thing to his neighbors. By carrying out the sanitary laws made for the benefit of the community, the fly menace can be prevented.

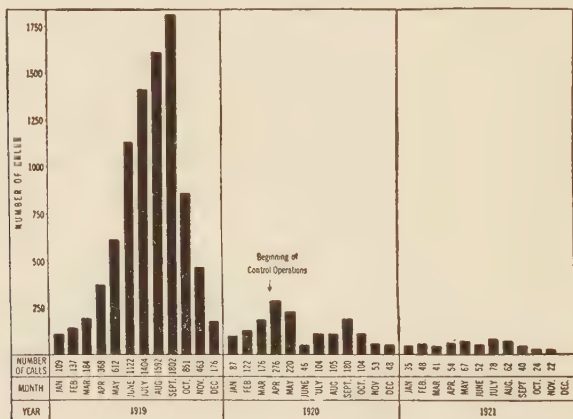
Home Experiment. — To see the effect of borax or kerosene when used in the breeding places of flies.

Some cities, as Washington, D. C., have made laws which cause manure to be placed in receptacles which must be emptied twice a week in hot weather. The city of New York requires that all stables shall be screened and manure removed at frequent intervals. All cities and towns should have some efficient laws which will prevent flies from maturing in stables. Manure heaps may be treated with borax at least once a week, using one pound per horse. Iron sulphate and lime also may be used. This method prevents flies from breeding in the manure heaps, but unless care is taken in cleaning the stables, small heaps of manure may be overlooked in which flies may breed.

Flytraps and their use. — Various flytraps are in use. Professor Hodge has invented one which deserves a wider use than it now has. This trap is placed over a hole in the cover of the garbage pail. If the cover is tilted a little, flies go into the garbage pail, but in trying to escape through the hole they go into the trap. In this way many thousands of flies may be trapped. One of the best ways to prevent the increase of flies is to have flytraps placed in the stable. In the house, while flytraps and fly paper may be used, the better method is the simpler one of poisoning flies by adding a one to two per cent formaldehyde solution to milk sweetened with a little sugar. If all other liquids are covered up, flies will go to the poison in great numbers. Wherever flies are found all food which attracts them should be screened.

How to start an anti-fly campaign. — One of the best ways for boys and girls to interest themselves in civic

betterment is to start an anti-fly campaign. For this purpose your school class in general science or biology may be of great use. Advertising material can be secured; the newspapers will help you; even the churches probably will be willing to aid in such a good work. The American Civic Association, with offices in Washington, D. C., will assist you in starting the campaign. If public senti-



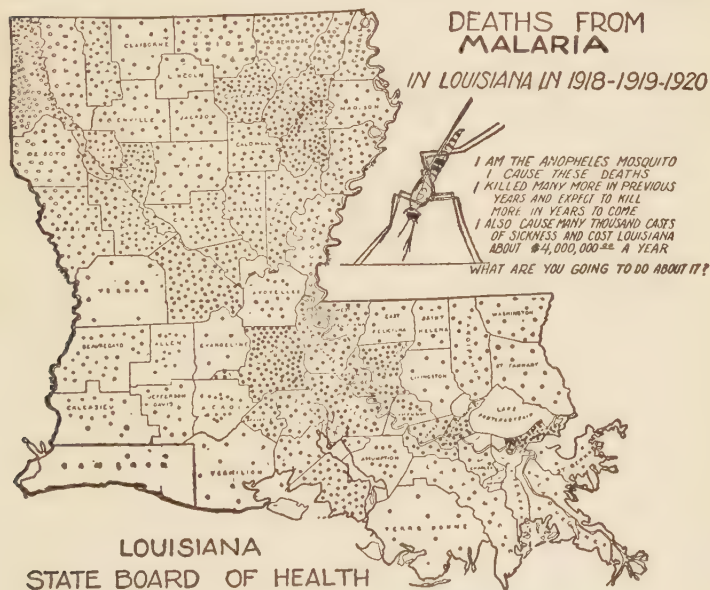
Courtesy of Rockefeller Foundation

Reduction in physicians' calls for malaria.

ment is aroused by means of meetings or otherwise, your city will wake up, make effective laws, and have them enforced.

Malaria. — For a good many centuries the development of certain areas in the world had been retarded by malaria. Italy suffered greatly, until she discovered that the extermination of mosquitoes meant the elimination of malaria. Many tropical countries are backward in their growth and in their production simply because laborers are not able to

work on account of malarial fever. In some parts of the South there are regions where malaria is so prevalent that from twenty to thirty per cent of the inhabitants have the disease. Although the death rate from malaria in this country is low (only 3 per 100,000), yet the number

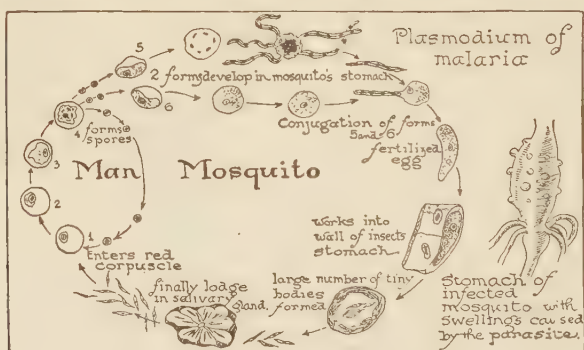


of persons who are kept from doing a full week's work by it is very great. It is estimated that the cost in dollars to the people of this country is \$100,000,000 a year from malaria. It is time, then, that we took every means to stamp out this disease.

What causes malaria? --- We have already read how the experiments of Dr. Ross of the English Army, based upon his belief in the theory of Sir Patrick Manson, resulted in

the discovery of the malarial parasite in the body of the anopheles mosquito. We read also how Dr. Warren and Dr. Manson, son of Sir Patrick Manson, verified Ross's discovery by proving that mosquitoes which had bitten malarial people could carry the disease to others. We shall now learn a little more about it.

The malarial mosquito, *anopheles*, does not cause malaria but transfers it. The cause is a tiny one-celled animal parasite. In order to live, this little animal (*plas-*



Life history of the malarial parasite.

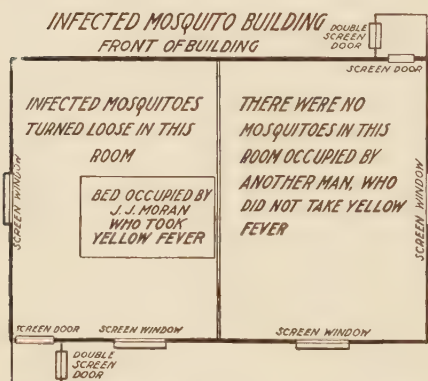
modium malariae) must pass part of its life in the body of the mosquito and part in the blood of a human being. When the anopheles mosquito sucks the blood from a person having malaria, the parasite passes with the blood into the stomach of the mosquito. It goes into the walls of the mosquito's stomach where it multiplies very rapidly and then gets into the body fluids of the mosquito and, is carried to the salivary glands. The mosquito's mouth waters when it starts to suck the blood from a person, and some of these little parasites are transferred into the human blood. Here they enter the red corpuscles, and

multiply rapidly. Eventually they fill the corpuscles full of little spores which break the corpuscles down, and then each spore enters another corpuscle. Thus are formed millions upon millions of these little parasites, each of which attacks a different corpuscle. At the time the corpuscle is broken down, a small amount of *toxin* or poison is released into the blood. The chill and fever of malaria is due to the breaking down of these blood corpuscles and the subsequent release of the poison.

How malaria is cured. — Of course, any one having malaria may move away from the place where it was received, but since the spores remain in the blood, attacks of malaria may recur from time to time. The only known cure is quinine. But as this has an effect upon a person's health, it should only be taken under the advice of a physician.

Yellow fever and its relation to mosquitoes. — In former times yellow fever was one of the most terrible epidemic diseases of this country, especially in the South and along the coast and as late as 1897 it was epidemic in New Orleans. For many years Cuba had been a hot bed of yellow fever. But after the war with Spain in the summer of 1900 a commission of four United States army surgeons worked there. Up to this time there had been two theories as to the transference of yellow fever. The prevailing one was that it was given by contact with matter given off from the patient. The other theory was that it was transferred by mosquitoes. Dr. Carroll, one of this group, from the army, was the first man to allow himself intentionally to be bitten by a mosquito carrying the yellow fever germ. Dr. Carroll had a severe attack but recovered, while Dr. Jesse Lezear, who also allowed himself to be

bitten by an infected mosquito, gave up his life in the attempt to prove the theory. A little later another experimental laboratory was established, and two young soldiers, John R. Kissinger and John J. Moran, volunteered their services in the cause of humanity. These



Camp Lezear, where first experiments to determine if the mosquito carried yellow fever were performed.

men lived for twenty days and nights in a small, poorly ventilated room with a temperature over 90 F., in close contact with articles of clothing and other materials taken directly from persons who had died of yellow fever. The soldiers were, however, all

of this time screened so that no mosquitoes could come near them. At the end of twenty days they were perfectly well. Moran then allowed himself to be bitten by an *Aedes* (formerly called *Stegomyia*) mosquito which was known to have bitten a yellow fever patient. He came down with the disease, but fortunately recovered. These and other results showed undoubtedly that yellow fever is carried by the *stegomyia* mosquito.

This discovery made possible our work on the Panama Canal. It is reported that when the French government was working on the Canal, eighteen young French engineers came over in one vessel and within a month all but one died of yellow fever, while of thirty-six nurses brought

over, twenty-four died of the fever in a short time. As soon as the United States Government applied the knowledge gained in Havana to the Canal Zone, it rapidly became a safe place in which to live. The last case of yellow fever occurred in this district in May, 1906. The eradication of this disease is a splendid tribute to the effective work of the United States army surgeons.

Experiment. — To see if oil will prevent development of mosquitoes in water.

How to exterminate mosquitoes. — The best way to exterminate mosquitoes, as house flies, is to destroy their



A building in the Canal Zone protected by screens.

breeding places. Mosquitoes lay their eggs in water in swamps and pools, slow-running streams, ditches, cess-pools, rain barrels and catch basins, hollow trees or even broken receptacles. The eggs hatch within two days into the little wigglers that you may have seen in rain barrels, and within two weeks they may emerge from the water as adult mosquitoes.

Our first effort should be, therefore, to clean up all dumps where broken cans or crockery exist, screen all rain barrels, cisterns, and privy vaults, drain ditch swamps

or, where the latter is not possible, pour crude oil upon the water. It can be proved easily that the wigglers are quickly killed if a film of oil is placed over the surface of the water where they breed. Such a film not only prevents the female from laying her eggs in the water, but clogs up the breathing holes of the young wigglers and kills them.

Small fish may be introduced into the ponds and streams as they eat the young stages of the mosquitoes. The best fish for this purpose are top minnows, goldfish, sticklebacks,



A health officer inspecting swamp water for mosquito larvae.



A member of sanitary squad applying crude oil to swamp.

and killifish. Night-flying birds, especially night hawks and swallows, feed on mosquitoes. Toads, frogs, bats, and dragon flies also are active enemies of mosquitoes, and should be protected wherever they are found.

Protection in the home against mosquitoes. — The most effective protection, of course, is to have no breeding places near one's home, as most mosquitoes fly only a short distance from where they are found.

How the community may fight the mosquito nuisance. — The strongest factor in fighting mosquitoes or flies in a community is public opinion. Since educated people make

public opinion, and since children of school age are being educated along these lines, it goes without saying that they can do much towards improving conditions. The school children of San Antonio, Texas, took up the task of exterminating the breeding places of mosquitoes and eliminated malaria within two years after they started to work. This is only one example of what has been done in many other places throughout the United States. The best way to start work is for the general science class or



Do rats find anything to attract them to your back yard?

the biology class to make a survey of the community and find out where the breeding places are, then go to the board of health or the school board and get assistance. Oil all the places that cannot be taken care of otherwise, have the children clean up yards or vacant lots where breeding places exist, and then show the public, by means of articles in the newspapers, and, if possible, through public meetings, what other work there is to be done. Report the facts of your survey to the county and state health offices. See what they will do to help. By means of such work the mosquito menace can be reduced if not eliminated.

The relation of fleas to the bubonic plague. — Plague, the Black Death of the ancients, was estimated in the fourteenth century to have killed 25,000,000 persons in Europe alone. It is now prevalent in Asia, and, as we know from the recent experience of San Francisco, its introduction into this country is always possible. Rats and ground squirrels become infected with the disease, and thus the fleas, which live upon them. When a rat dies of plague, the fleas leave it and then go to another, or possibly to a human being, who becomes inoculated with the plague if bitten. In San Francisco fully 1,000,000 rats were killed, thus partially removing one means of infection. To exterminate rats completely is almost impossible. General clean-up measures are necessary, and by the use of pyrethrum powder, benzine, or naphthalene flakes one may rid a house of fleas.

REFERENCE BOOKS

- Brown, *Health in Home and Town*. D. C. Heath and Company.
Directions for Making a Homemade Flytrap. International Harvester Company, Chicago.
 Doane, *Insects and Disease*. Henry Holt and Company.
 Dunn, *The Community and the Citizen*. D. C. Heath and Company.
 Finch, *Everyday Civics*. American Book Company.
 Howard, *The House Fly*. F. A. Stokes Company.
 Hunter, *A Civic Biology*. American Book Company.
 Hunter, *Laboratory Problems in Civic Biology*. American Book Company.
 Jackson, et al., *The Housefly at the Bar*. Merchants' Association of New York.
 Jewett, *Town and City*. Henry Holt and Company.
 McCarthy, et al., *Elementary Civics*. Thompson, Brown and Company.
 Parsons, *Disposal of Municipal Waste*. (For teachers.) John Wiley and Sons.
 Ritchie, *Primer of Sanitation*. World Book Company.
 Ross, *The Reduction of Domestic Flies*. J. B. Lippincott Company.
 Trafton, *Science of Home and Community*. The Macmillan Company.
 Venable, *Garbage Crematories in America*. (For teachers.) John Wiley and Sons.
 Winslow, *Healthy Living*. C. E. Merrill Company.
 Wood, *Sanitation Practically Applied*. (For teachers.) John Wiley and Sons.

SCORE CARD. PUBLIC SANITATION

	PERFECT SCORE	MY SCORE
MOSQUITOES AND FLIES If no mosquitoes (10); if culex only (5); anopheles present (0) If no flies in public places, in stores, on street, etc. (10); if few flies (5); if many (0) An effort is made by community to destroy mosquito breeding places (5) Public inspectors prevent fly breeding places, as accumulations of stable manure (5) Interest aroused in anti-fly campaigns or anti-mosquito campaigns (5)	35	
REMOVAL OF WASTE Garbage removal daily in hot weather (5); twice weekly (3); weekly (0) Ashes and rubbish collected weekly (5) Public sewer or septic tanks used (5) Sale of refuse pays the city in part at least for its removal (5) Vacant lots and roadsides well kept; free from weeds and rubbish (5)	25	
STREETS Manure and litter removed twice a week (5) Cleaned by wet process. Flushed or swept while wet (5) Dust kept down by frequent sprinkling or by oil (5)	15	
FOOD Restaurants clean and inviting; food appetizing (5) Have paper cups at soda fountains (5) Food usually eaten unwashed kept in stores where it cannot be handled (5) Food usually eaten unwashed kept in stores where customers will not cough or sneeze into it (5) Fruits and bakers' foods protected from dust and flies (5)	25	
TOTAL	100	

CHAPTER XXIII

STREET LIGHTING

Problems. — 1. *To learn how street lighting began.*
2. *To learn the source of various street illuminants.*
3. *To understand the processes of gas manufacture.*
4. *To understand how electricity is produced.*
5. *To see how street lighting fixtures may beautify rather than mar the city streets.*

Suggested project. — 41. To make a survey of street lighting in a section of my community.

The history of street lighting. — Gas and electric lights are so common to most of us that it seems as if cities had always been lighted in this way, but it was not until 1415 that street lights were introduced into London. For three hundred years householders were obliged to hang lanterns in front of their houses during the winter evenings. Forgetful people were reminded by the passing watch with these words:

Light here, maids, hang out your light,
And see your horns be clear and bright,
So that your candle clear may shine
Continually from six to nine,
That honest men may walk along,
May see and pass safe without wrong.

Street lighting began in this country when New York passed a law in 1698 to the effect that every seventh house

should hang out a light on the end of a pole. Previous to that time the only street lights were those that shone from the houses. Many small towns in Colonial times required citizens to keep a light in their front windows until certain hours each night. In the latter part of the eighteenth century London was well lighted with oil lamps having wicks and glass chimneys which



A night scene in New York about 1698.

were cared for by the city. Street lighting by gas was introduced in England in 1807, and in this country in 1817, when Baltimore installed a gas plant for that purpose.

Chief sources of street lighting. — At present the two principal sources of artificial light for city streets are gas and electricity, although oil and acetylene are still used in some rural communities. Both natural and artificial gas were burned as bare flames until within recent times, when gas mantles were introduced. The competition between gas and electricity has been very keen. Both have been much improved of late in methods of control and of service rendered.

The reasons for lighting streets. — To any one who has passed through a well-lighted district and a poorly-lighted one the reasons for street lighting are very apparent. Good lighting results in increased traffic, increased trade in the stores, an increase in property value, a decrease of crime,

and in the number of accidents. Industrial accidents are shown to increase during the season of short daylight when more work is done under poorly-lighted conditions. Street accidents increase at the same time as more accidents occur in poorly-lighted streets. An up-to-date community



A well-lighted street.

demands well-lighted streets. Reflectors which spread light in ovals instead of circles give a greater efficiency.

What constitutes good street lighting. — Good street lighting means soft and cheerful lights placed close enough so that there are no dark recesses and no objectionable shadows.

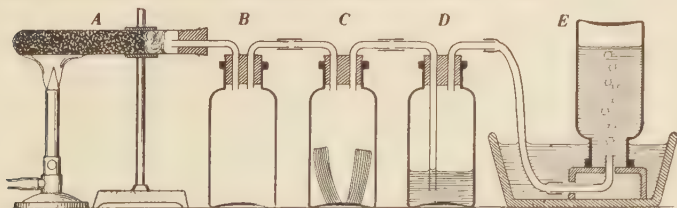
Lighting by natural gas. — Natural gas is obtained by drilling in much the same way as for oil, and it is found closely associated with oil. Frequently in drilling for oil natural gas is found instead. West Virginia is the greatest natural-gas-producing state. Cities more than one hun-

dred miles distant from the wells are supplied with natural gas for one-fourth as much as artificial gas costs. Natural gas can be used without any purifying, but, since the high price of gasoline, it is robbed of its gasoline contents before it is distributed through the gas mains.

Manufacturing artificial gas. — Artificial gas for street lighting is usually manufactured by

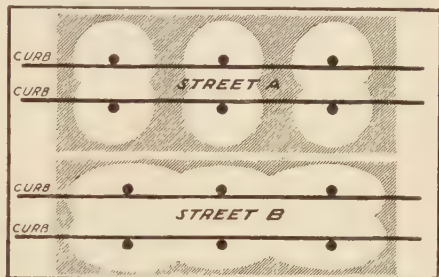
one of two methods: either by the process of destructive distillation of coal or by what is known as the water-gas method. Since the use of gas mantles for street lighting, both kinds of gas are frequently produced in the same plant, and are mixed in the mains for use with the mantle lamps.

Demonstration Experiment. — To examine some of the products resulting from the destructive distillation of soft coal.



Materials: Soft coal, red litmus paper, filter paper, lead nitrate or lead acetate, limewater, hard glass test tube, and collecting bottles.

Method: Set up apparatus as in figure. *A* is a hard glass test tube containing coarsely ground soft coal $\frac{3}{4}$ full. *B* is an empty bottle. *C* is a bottle holding (1) a piece of filter paper moistened with lead



Are there dark areas between the street lamps in your town? Compare streets A and B above.

nitrate or acetate solution, and (2) a piece of moist red litmus paper. *D* contains limewater. *E* is a wide-mouth gas-collecting bottle. Place the litmus paper as near as possible to the mouth of the inlet tube in *C*. Heat the hard glass test tube gently at first, and when thoroughly warmed increase the heat, using two flames if possible. Look for any change in the litmus paper. This change does not always occur, even when the experiment is carefully performed, as the temperature condition for driving off a sufficient amount of ammonia is difficult to attain. An acid turns blue litmus red and an alkali turns red litmus blue. Hydrogen sulphide, an impurity in the gases from coal, turns lead nitrate or acetate black. Collect two bottles of gas after all the air has been driven out of the apparatus.

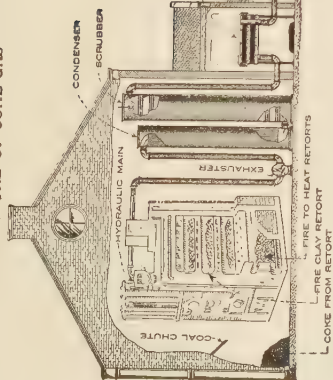
Results: Determine if the gas will burn. Describe and name the product in *A*. Note the properties of the matter in *B*. Account for any change in the two papers in *C*. Explain the change in *D*. Give the commercial name of the gas collected in *E*.

Conclusion: What products can you identify as produced from the destructive distillation of soft coal?

Application: What substances identified are of importance commercially?

How coal gas is manufactured.—Soft coal which contains from 30% to 40% of volatile matter is placed in a retort, and in the process of heating is turned into coke. The gases and by-products pass off through what is known as a hydraulic main. In the hydraulic main some of the tar is condensed and still more of it is taken out a little later by what is known as the tar extractor. The gases are then forced through a spray of cold water in condensers and scrubbers by means of which the ammonia and other by-products are removed. After the gas has been purified it is passed to a huge tank or holder, which is a familiar blot on the landscape of many cities. From this holder the gas is passed out through the city mains and is distributed to the street lights and to the homes, where it is used for cooking, lighting, and heating purposes.

MANUFACTURE OF COAL GAS



MANUFACTURE OF CARBURETTED WATER GAS

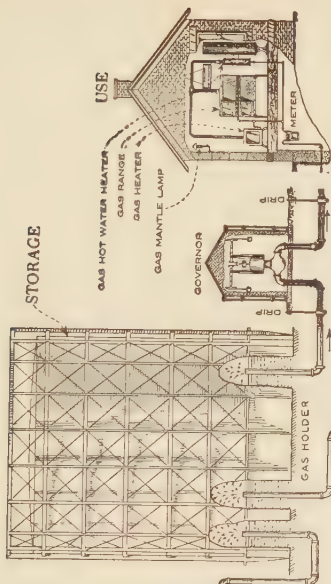
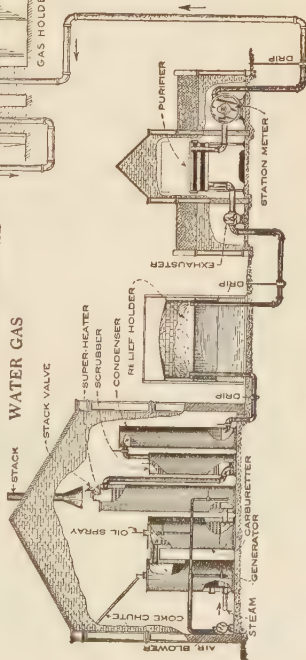


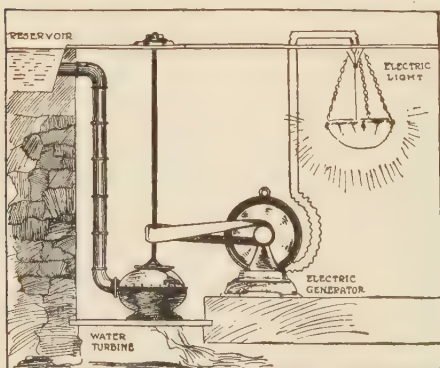
Diagram showing how gas is manufactured and distributed to user.

In making gas a ton of coal produces on an average two-thirds of a ton of coke, 13 gallons of coal tar, 20 pounds ammonium sulphate and 12,000 cubic feet of gas. The by-products obtained from the coal tar are far more valuable than the gas or coke which is produced. Such substances as aniline colors, light and heavy oils, carbolic acid, and naphthalene flakes are some of the products thus obtained.

Water gas. — Water gas is often mixed with ordinary coal gas for purposes of street lighting and home use. It is made by passing steam under pressure through incandescent hard coal or coke. The gases pass off into a structure called the *carburetor* where coal oil is sprayed into them. They then pass to the superheater, where they are changed to a permanent gas which will burn. It is cheaper to make water gas than coal gas, but without

extensive enriching with oil the water gas is not suitable for lighting unless mantles are used.

Demonstration Experiment. — To compare acetylene with city gas for illumination.

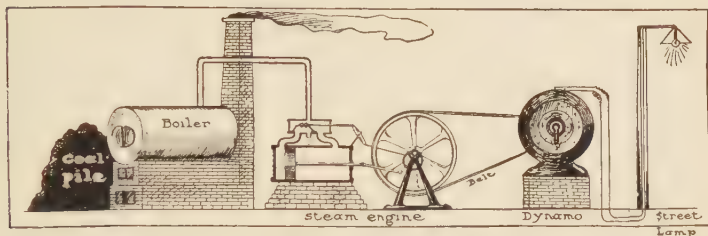


Energy of falling water changed to light.

Electricity for street lighting. —

We have already seen that electricity can be made cheaply where there is water power. Falling water releases mechanical energy which may be changed to electrical energy. This change

is an illustration of the *law of the transformation of energy* and another example of it is shown when electricity is produced from coal in the following way. Coal is burned in a furnace under a boiler which produces steam that



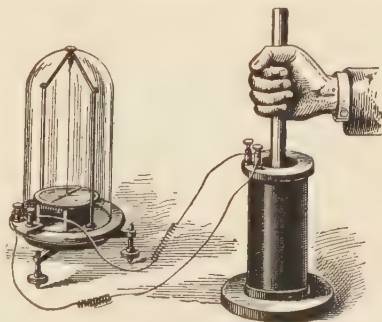
Name the changes in energy suggested above.

makes the wheels of a steam engine revolve. The steam engine in turn rotates the armature of a dynamo and electricity results.

Demonstration Experiment. — To see how an electric current is produced.

Materials: A coil of wire. A strong bar magnet, a galvanometer. Connecting wires.

Method and Results: Connect the ends of the wire forming the coil to the galvanometer, thus making a "closed coil." Move the magnet in line with the axis of the coil down into the coil. Quickly withdraw the magnet. Observe the galvanometer needle in each case. Hold the magnet still inside the coil. What result?



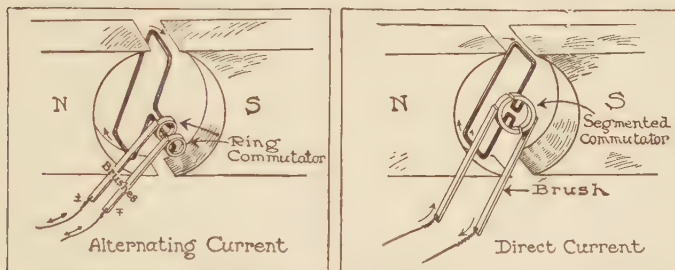
Conclusion: The movement of the galvanometer needle is due to a current of electricity. The magnet is surrounded always by lines of magnetic force. Under what conditions of coil and magnet does a current result in the coil?

Application: Similar relations between closed coils and magnetic lines of force exist in the dynamo. Can you tell how it is then that a dynamo produces electricity?

How electricity is produced. — When a closed coil of wire is moved across the lines of force in a magnetic field a current of electricity is produced. A dynamo is a device which produces this current. It has an electromagnet by means of which a powerful magnetic field may be produced. Between the poles of the dynamo an armature consisting of many coils of wire is rotated. The two ends of each coil of wire terminate in the commutator consisting either of a pair of metal rings or of segments separated by insulating material. As the commutator revolves it touches fixed strips of conducting material known as the brushes. Wires which carry the electricity away to do its work are attached to the brushes. Some dynamos have a revolving magnetic field and a fixed armature, but the principle of producing electricity in them is the same. There is always relative motion between the magnetic field and the coil of wire. The dynamo is also called a *generator*.

Alternating current and direct current. — As one side of the wire coil of the armature passes the north pole of the magnet a current results in a certain direction. As it passes the south pole the current is produced in the opposite direction, thus in every revolution of a coil of wire between two magnetic poles two currents of electricity are produced. As the coil continues to revolve the current is alternating; going first in one and then in the opposite direction. This current is called from its change of direction, an *alternating current*. The alternating current is taken off by brushes in contact with a ring commutator. If, however,

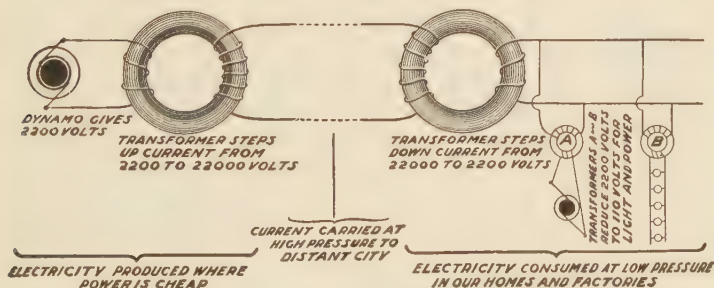
a segmented commutator is used, the brushes take off a *direct current* of electricity. Either a direct current (D. C.) or alternating current (A. C.) may be used with incandes-



A simple diagram to show the principle of the dynamo. Lines of magnetic force fill the space between the ends of the magnets N and S. As the coil of wire is rotated in this space electricity is generated in the wire. When distributed just as produced, an alternating current (A. C.) results, but when a segmented commutator is used, a direct current (D. C.) results in the outside circuit.

cent lamps but as a rule the direct current is preferred for arc lights.

Use of transformers. — Transformers are devices used for “stepping up” or “stepping down” the voltage.



The use of transformers in a system of distribution of electrical energy.

When a large current of electricity is carried a long distance there is a very great loss of energy due to the heating of the conducting wires. When electricity is carried the

long distance at a high voltage and correspondingly low current, there is little heat produced and so only a small loss of electrical energy results. The transformer makes it possible to carry electricity at high voltages and to step it down just before it is used. A direct current cannot be changed by the use of the transformer to a different voltage, but the alternating current can. For this reason electric lighting circuits usually have the alternating current.

Demonstration Experiment. — To demonstrate the use of a transformer.

Materials: Two bell transformers for changing 115 V. to 6 V., 12 V., and 18 V. An A. C. voltmeter reading to 130 volts. Wire.

Method and Results: Measure the voltage of the A. C. electric light current.

(a) Connect the transformer to the lighting circuit. Measure the voltage obtained in each of the three secondary circuits. Results?

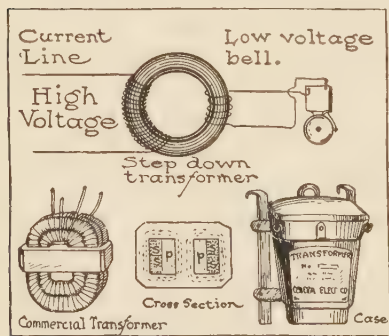
(b) Connect two binding posts of the secondary circuit of one transformer to the two corresponding binding posts of the other transformer. Connect the primary of one to the lighting circuit and what would ordinarily be the primary of the second,

but which as now used is a secondary to the voltmeter. Result? How do you account for the result?

Conclusion: Of what value is the transformer?

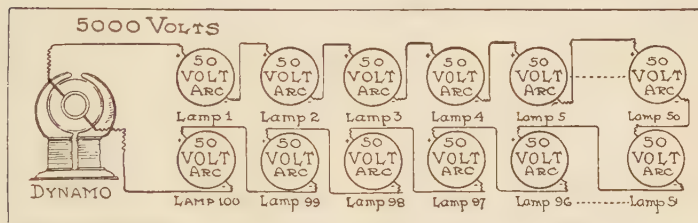
Application: Why are transformers used in electric lighting systems?

Types of electric lamps. — There are two types of electric lamps used for street lighting, the arc lamp and the



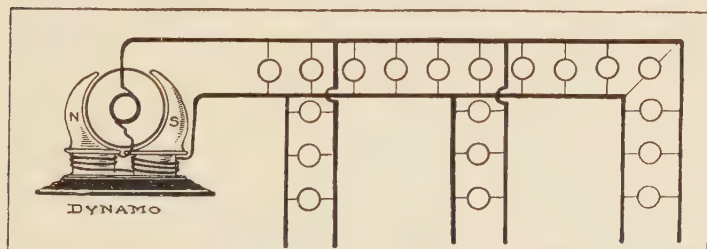
How can three different voltages be produced if there are only two separate secondary coils?

incandescent, and there are many forms of each type. When an electric circuit is closed by the contact of two carbon pencils, great heat is generated by the resistance at the point of contact. Carbon at the point of contact



Arc lamps are connected in series.

becomes vaporized and if the carbons are drawn a short distance apart this vaporized carbon continues to carry the current of electricity. Inasmuch as this stream of highly heated vapor usually bends out in the form of an arc, this is called an *arc light*. Closed arc lights are used



Incandescent lamps are connected in parallel.

almost always now because they last longer than open ones there being little oxygen present in the bulbs to burn them up.

The most important use of the heat derived from an

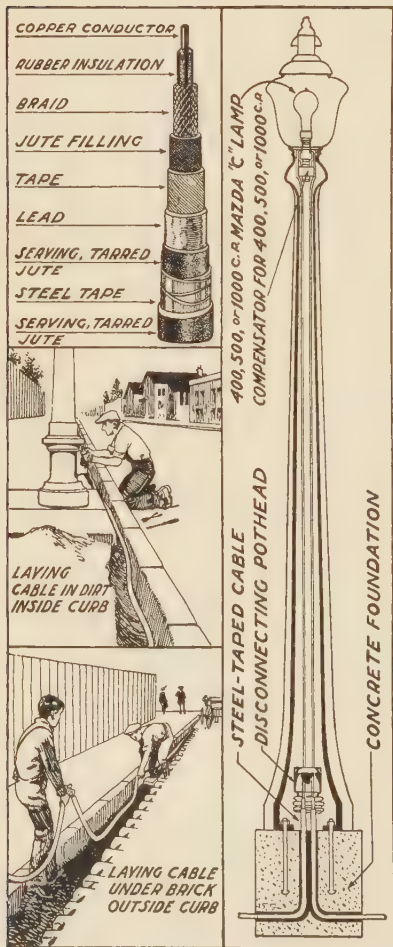
electrical current is in the heat of the filaments of incandescent lamps to produce light. The larger tungsten

lamps run from one hundred to five hundred or more candle power, and are in common use for street lighting. These lamps are gradually replacing the arc lights in many cities.

Lamp circuits.—

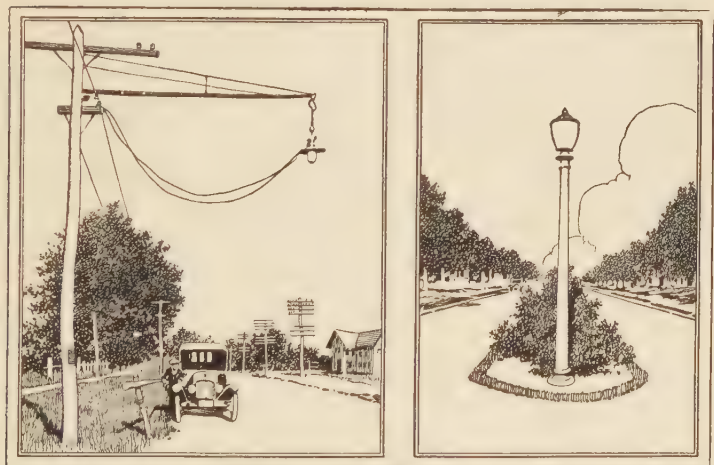
When arc lights are used, the lamps are placed in a series, each lamp taking about fifty volts. A circuit with one hundred lamps would, therefore, require 5000 volts. Incandescent lamps, on the other hand, are connected in parallel. A 110-volt circuit would be sufficient for any number of lamps so joined.

How electricity is sent to the consumer. — A few years ago it was a common sight to see the streets of cities disfigured by huge poles



Electric street lamp showing wiring. Method of cable laying. Insulation of cable.

bearing many wires. In modern communities all telephone and electric light wires are placed in conduits underground. This use of underground cables instead of overhead wires is a great advantage as there is no trouble from broken wires in storms, less danger to people, and the streets are more beautiful. While the first installation is expensive, the wires are so well protected that they last a long time,



Utility lighting vs. ornamental lighting.

and the final cost of underground cables is not much greater than that of the overhead system of wiring.

Beauty a detail in street lighting. — While utility is the first consideration in street lighting, yet the modern community should consider beauty as well. Ornamental fixtures, reflectors, and globes cost but little more than ugly ones, and it may be that for the added attractiveness they give, a city will be repaid eventually in a financial way. There is no doubt but that they pay in the satis-

faction they give to one's aesthetic sense. In many towns the value of property along certain streets has been increased 50% by the introduction of adequate and ornamental street lights.

REFERENCE BOOKS

- Articles on *Street Lighting*. The American City, New York.
- Barber, *First Course in General Science*. Henry Holt and Company.
- Brownlee, et al., *Chemistry of Common Things*. Allyn and Bacon.
- Blanchard and Wade, *Foundations of Chemistry*. American Book Company
- Dunn, *The Community and the Citizen*. D. C. Heath and Company.
- Hodgdon, *Elementary General Science*. Hinds, Hayden and Eldredge.
- Hughes, *Community Civics*. Allyn and Bacon.
- Lecture 8, *Evolution of Street Lighting*. General Electric Lecture Service, Schenectady, New York.
- McPherson and Henderson, *Elementary Study of Chemistry*. Ginn and Company.
- Municipal Year-book*. City of New York.
- Ziegler and Jaquette, *Our Community*. J. C. Winston Company.

CHAPTER XXIV

HOW THE COMMUNITY PROTECTS AND EDUCATES ITS CITIZENS

Problems. — 1. *To learn the various duties of the police force.*

2. *To understand the value of law and order.*

3. *To understand how the fire apparatus "works."*

4. *To see the value of heeding traffic regulations and fire regulations.*

5. *To understand the relation of various city departments in the promotion of safety for citizens.*

6. *To see how schools, libraries and museums may aid in our education.*

7. *To see how various amusements may be also educational.*

8. *To see what community forces are working for higher standards of morality and to aid moral education.*

Suggested project. — 42. *To study the fire equipment at a near-by fire station.*

Law and order. — When a group of people live together in a community, each individual has certain rights which must be respected by the others. There is considerable difference in the way different individuals, who insist upon their own rights, accept the restrictions of their own actions. In every community there are likely to be some people

who insist upon violating the rights of others at every opportunity. It is to the best advantage of every community to be governed by national and state laws and in addition by the regulations of the city or community.

A modern police system. — The City of New York has an army of somewhat over ten thousand policemen which



A traffic officer.

is divided into a number of squads; Those in one squad are called patrolmen, and they have charge of the law and order on the streets of the city. Another squad patrols the harbor, using over a dozen boats for this purpose. Another group has charge of the

violations of the motor vehicle laws. Another branch inspects the steam boilers in various parts of the city. While a separate squad makes up the bureau of criminal identification and has charge of the "rogues' gallery," with its systems of measurements, its criminal records, and its finger print system. This bureau conducts also a school for detectives. Besides these there is a headquarters building with its corps of officials whose business it is to direct the entire police system. The patrolmen regulate traffic on the busy streets and keep crowds back when parades are moving through the streets, and at all times serve the people. It is their duty to arrest offenders

against law and order, to protect property against theft, and to protect our lives against violence.

The patrolman is also an inspector of the general condition of the streets, of defective sewers, broken electric

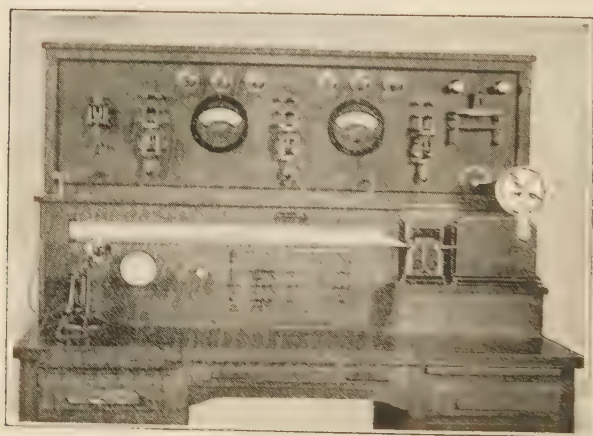
DIVISION	POLICE DEPARTMENT CITY OF INDIANAPOLIS	DIST.NO.
PATROLMAN'S REPORT		
Date _____ 19__		
To the Board of Health through the official channels of the Police Dept.		
At _____ M. I observed the following condition and took the action noted		
Location _____		
Insanitary Alleys	☐	
Insanitary Backyard	☐	
Insanitary Garbage Cans	☐	
Insanitary Vaults	☐	
Overcrowded Houses	☐	
Improper Ventilation of Public Buildings	☐	
Food Unprotected from Dirt and Flies	☐	
REPORT HERE ANY OTHER MATTER NOT LISTED		
Action Taken _____		
(Rank) (Signature) (Badge No.) P.D.508		
BLANK FOR PATROLMAN'S REPORT TO BOARD OF HEALTH		

DIVISION	POLICE DEPARTMENT CITY OF INDIANAPOLIS	DIST.NO.
PATROLMAN'S REPORT		
Date _____ 19__		
To the Board of Works through the official channels of the Police Dept.		
At _____ M. I observed the following condition and took the action noted		
Location _____		
Broken Curb Stone	☐	Broken Electric Wire ☐
Broken Manhole Cover	☐	Sagging Electric Wire ☐
Broken Sidewalk	☐	Broken Street Lamp ☐
Defective Bridge Culvert	☐	Leaking Gas ☐
Defective Sewer Catch Basin	☐	Leaking Hydrant ☐
Hole in Street	☐	Broken Water Main ☐
Street Opening not Repaired	☐	Unclean Street-Outlets ☐
REPORT HERE ANY OTHER MATTER NOT LISTED		
Action Taken _____		
(Rank) (Signature) (Badge No.) P.D.511		
PATROLMAN'S REPORT BLANK FOR RECORDING CONDITIONS FOR ATTENTION OF BOARD OF WORKS		

Blanks for patrolmen's reports.

wires, broken street lamps, leaking gas mains, leaking hydrants, broken water mains, and many other matters of a similar nature. The records which are turned in by the police have to be models in accuracy and in detail, and after having seen such a record we should have added respect for the duties which these men have to perform.

The police patrol signal system. — The police headquarters in city districts have a signal system which is electrically equipped so that it registers approximately the location of every patrolman at any time and makes it possible to hold a telephone conversation with him whenever he reaches the police signal station from which he sends word of his presence. There is a double advantage in this system. The patrolman can easily send messages



Police signaling desk at headquarters.

to headquarters with little delay, and the line is never "busy" but is always open for his message. Headquarters can, within a short time, reach any patrolman if it is necessary to send him a message.

Prevention of accidents. — Traffic police officers are the greatest factor in the prevention of accidents. Almost as many thousands of American people were killed in the United States during the World War from accidents as were killed in France. It is not merely in the street traffic

that there is great danger, but street cars and railroad grade crossings, fallen electric wires, unguarded excavations, unsafe railings, and icy sidewalks and pavements all add their quota to the list of accidents.

Safe and sane driving. No regulations and no officers can prevent accidents which are invited by the recklessness or carelessness of drivers. Fortunately, since police regu-

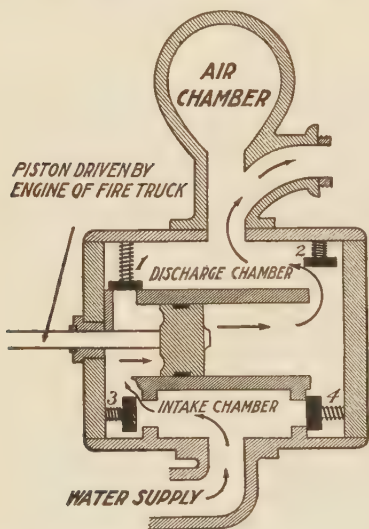


Wreck of the reckless driver.

lations are strict within cities, most drivers heed traffic regulations fairly well. Careful drivers seldom get into trouble. They cannot, however, escape from the danger into which they are forced by careless drivers who ought to lose their licenses.

The equipment of a fire department. — Most of us have enjoyed a visit to the fire station. The wide open doors, the shining brass of the engines and trucks, the stall where

motor apparatus has replaced the intelligent-looking horses, and the brass pole from the upper story where the firemen slide down when hurrying to a fire, have all left their impressions upon us. The complicated system of fire signals is always interesting, and especially so when an alarm is rung. The



Explain how the piston in moving back and forth drives water out on each stroke.

“chemical” is usually the first piece of apparatus to arrive at the fire and can extinguish a small fire without any hydrant connection. It is really a large carbon dioxide fire extinguisher in which sodium bicarbonate and concentrated sulphuric acid are used. The motor fire truck of today has a powerful double acting force pump operated by the gasoline engine of the truck. This pump draws water from

a hydrant or any other available supply and throws a stream of water more than one hundred feet. The action of the pump will readily be seen by studying the figure.

Demonstration Experiment. — To see how the force pump works.

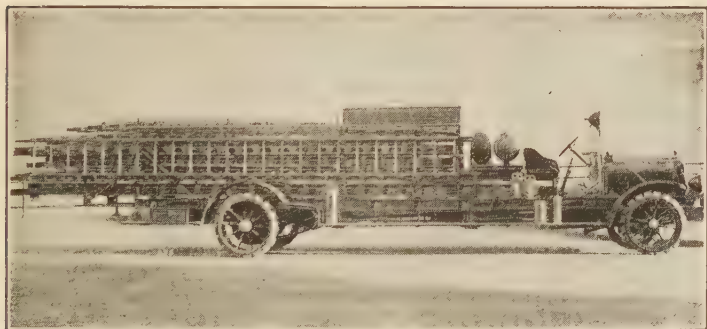
Materials: Glass model of force pump with air chamber. Shallow jar or basin.

Method: Operate the pump. Watch the valves.

Results and Conclusion: Explain the action. What seems to be the purpose of the air chamber?

Application: What advantage would the double acting force pump used on fire engine have over this type?

Other fire equipment. — In addition to the engines, firemen must have means of reaching the fire from the outside, and also for cutting through roofs and pulling or pushing over partly burned walls. The hook and ladder answers this purpose. In some large cities water towers are used which are really extension ladders, bearing a large nozzle from which a stream of water may be directed to better advantage; safety nets to catch people who may have to jump from windows in burning buildings are



Ladder truck with hooks, poles, axes, and chemical equipment.

also a part of the equipment. We find most up-to-date fire departments equipped with oxygen helmets by means of which firemen can go into dense smoke without being suffocated. There are also pulmotors used to restore to normal breathing people who have been suffocated; these give them oxygen under pressure at regular intervals.

The fire alarm system. — The first fire alarm telegraph system was installed in Boston in 1852. The original box contained practically nothing but a telegraph key operated by a notched wheel that opened and closed the circuit. To-day there is scarcely a city or large town

which does not have a system for telegraphing an alarm. In the modern system all wires are placed underground, which improves the efficiency of the system and also the appearance of the streets.

Fire protection in public buildings. — It was reported by the Russell Sage Foundation that each week fire wipes out of existence in the United States ten school buildings, two college buildings, two hospitals, three public halls, two jails, and twenty-six hotels. In 1918 the damage to school



The soft solder which holds the valve closed melts at about 180° F. When melted it opens in the fraction of a second. The pictures above were taken with a moving picture camera.

buildings alone was over \$5,500,000. Buildings can be replaced but lives cannot. Thousands of lives are lost in fires every year, because as a rule public buildings, especially schools, are not properly protected against fire. Every school, orphanage, hospital, and other public building should be equipped with a private fire alarm system, and this system should be arranged so that it can be detached from the city alarm when fire drills are held. Most fires that occur in schools originate in closets or in basements; therefore, these places should be equipped with an automatic sprinkler system. By means of such

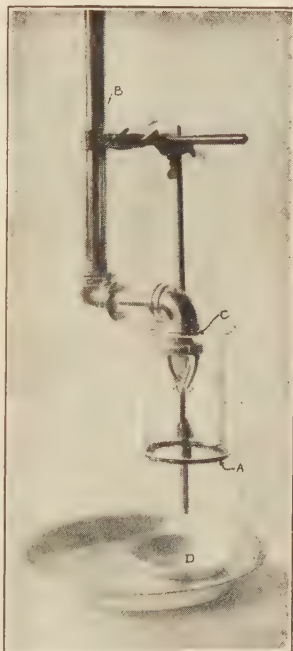
a system whenever a certain temperature is reached in a room, the valves which close the water pipes automatically open through the melting of a soft metal cap, and the water is sprinkled to extinguish the fire.

Demonstration Experiment. — To demonstrate the automatic sprinkler.

Materials: A sprinkler demonstration set.

Method: Place the sprinkler demonstrating set over a sink or place a large heavy paper under it to protect the table top. A large shallow pan will catch most of the water. A small metal dish (*D*) to hold the fire is placed in larger pan and is separated from it by a thick layer of asbestos. Shredded asbestos wet with denatured alcohol is placed in the small dish, covering the base to a depth of $\frac{1}{4}$ inch. "Canned heat" may be used in its place. A glass cylinder is used to prevent the water from spreading too much. This is supported by the iron ring (*A*) a few inches above the fire pan. Adjust the elbow (*C*) to 5 inches above the iron ring. The pipe (*B*) is filled with water and the fire lighted.

Result and Application: Describe just what happens and apply the result to a real fire in a school basement.



Sprinkler demonstrating set.

Fire regulations. — In nearly every large community the city government has passed certain ordinances relating to fire hazards. These regulations refer to the storage of inflammable materials, to the location of garages, to the methods used in building, to the location of exits and fire escapes on buildings, to the use of fire safe-

guards in theaters, and to the separation of the more congested districts into zones where stricter regulations against fire are enforced.

Other departments concerning the safety of life and property. — There is scarcely a city department which does not in some way contribute to the safety of the citizens and of their property. Besides the fire, police, and health departments we have the department of streets, which looks after construction, pipe laying, and repair, keeping them and the sidewalks safe for public use; the water department, which furnishes water to extinguish fires



The sealer of weights and measures prevents much fraud. Explain how the dishonest dealer who used the scales shown above cheated his customers.

as well as for home or factory use; the building inspectors, who prevent new fire hazards; the department of weights and measures, which prevents fraud through the use of false weights and measures; the department of street lighting, which, as we have seen, helps to make the city safe at night. In addition to these each individual in the community must play his part and help the work along.

How citizens may help. — “Safety first” is a very good slogan; not only one’s safety but that of the other fellow as well. We may all help like good citizens by protecting the property of others; by taking care of city

supplies; by seeing that city ordinances are enforced; by obeying all laws or ordinances with reference to the safety of buildings; and, finally, by willingness to enter

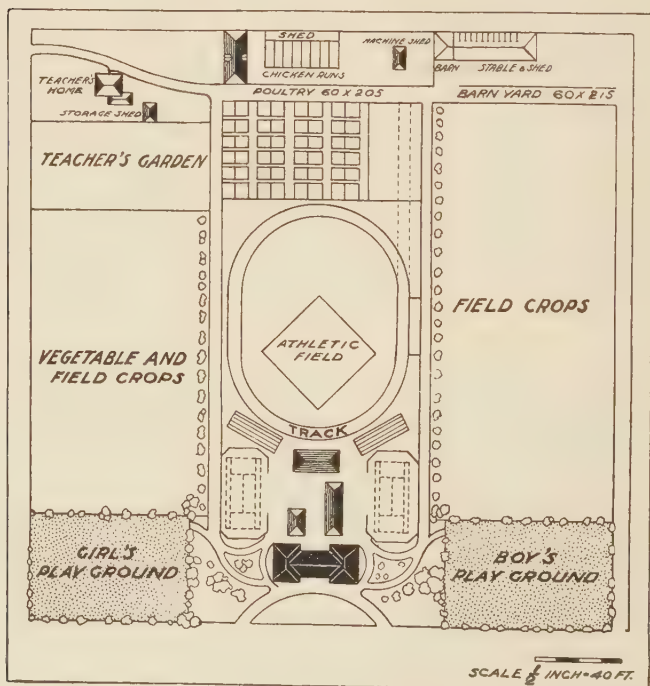


A hazardous practice. How much better it would be always to avoid danger.
(Travelers Insurance Co.)

into such routine as the fire drill in school, whereby a score of lives may be saved if a real school fire occurs.

Schools and their work. — Most of us take the public schools as a matter of course, and do not even say “thank

you " always. As a matter of fact, the public school system in this country is something for which we may be proud. Nearly \$500,000,000 a year is spent for free schools, an average of \$26 for each child enrolled. This



Ideal plan for rural school grounds. Can you help to plan better grounds for your community?

democracy of ours offers unlimited opportunity to those who avail themselves of its educational advantages. A child may get much from our free system of education, but later we expect him more than to pay for it, in his work as a citizen. Schools are a kind of a community and

should give training for life. Each subject we study should help us, in some way, to become better citizens. Science teaches us to think straight and to understand many civic problems; language helps us to speak and write intelligibly; history and civics show us how to become good citizens. Athletics help us toward certain splendid standards of citizenship: honesty, good sportsmanship, quickness in decision, and square dealing with the other fellow.

Colleges, universities, and technical schools. — All parts of our land to-day are supplied with institutions of higher learning. More and more the young people are availing themselves of the opportunities for higher education. Especially is this true in science. We have awakened to the fact that training in science is necessary not only for straight thinking but also for advancement in the world of to-day. Engineering schools, medical schools, and all kinds of technical schools are more important than ever before, and their attendance is growing year by year. Manufacturing and engineering corporations are endowing scholarships so that worthy young men in their employ may get a free education along lines necessary to earn promotion. No young man with ability need fear that he may not succeed if he is willing to work.

Modern school buildings. — The modern school building is fireproof and has well-lighted halls and stairs, since many children are within it for several hours each school day. The large, airy rooms have, where possible, outside overhead lighting, and where this is not possible, light comes in from large windows on one side only. Artificial light when used is diffused and without a glare. The desks and seats are adjustable, so that each individual child has

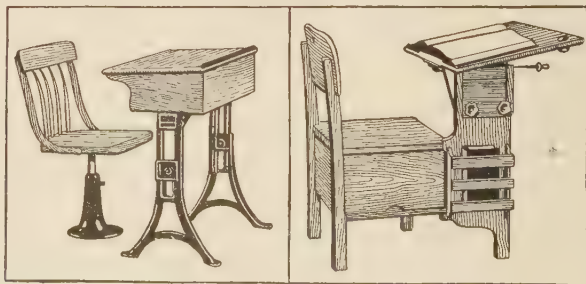
a desk of the right height. Ventilation is most satisfactory when there is a complete system which keeps the air in circulation and warms, filters and humidifies it.

But good ventilation may be obtained by windows open at the top and bottom. Where the air is dry, pans of water should be kept on the stoves or radiators.



Curtains adjustable at both top and bottom remove much glare and eye-strain.

Hygiene should be practiced in every way in the schools. Sanitary drinking fountains should always be provided. The best form is one which throws a stream of water to one side, so that the lips need not be pressed against the fountain when drinking. It goes



Adjustable seats and desks.

without saying that individual paper towels should be placed in the wash rooms and that the toilets, without

wood in their construction, should be well ventilated, and flushed frequently. Dry sweeping should not be allowed. Experiments in certain New York schools have shown that where dry sweeping is done carelessly the bacterial content of the air becomes very great.

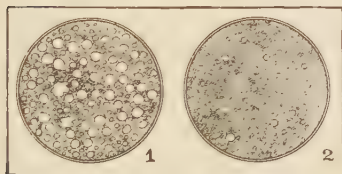


Plate cultures. 1. Dry Sweeping.
2. Damp Sweeping.



A good fountain for public use.

Libraries and museums as aids in education. — Not only do most communities have free libraries, but many



A library reading room.

of them use the building for more than simply taking out books. Many boys and girls not fortunate enough to

have a quiet room of their own at home in which to study may use either the reading room or some other room in the public library. Libraries are used as meeting places for literary and social clubs, and for lectures as well. Museums of art and of natural history are also indirectly great educational centers. Most museums have lecture courses, collections which they lend to public schools, and rooms set apart to which the collections may be taken by students and teachers for laboratory work.

Playgrounds and the playground movement. — Any boy who reads this chapter may well object that up to the



The place for enjoyable exercise in summer.

present time nothing has been said about recreation. He may well ask, "What does the city do for a red-blooded boy?" Fortunately, we have come to realize that boys and girls of school age need play and recreation as well as work. In the past ten years hundreds of playgrounds

have been opened in cities and towns, and maintained by the park departments, boards of education, settlement houses, and associations interested in the playground movement. In these places boys and girls as well as grown-ups may play in safety and under the supervision of a trained instructor. Many cities, notably New York, Chicago, and Washington, have well-equipped



Parks are the "breathing places" of our large cities.

playgrounds and recreation centers with club houses, swimming pools, bath houses, out- and in-door gymnasiums, running tracks, and fields for games. School yards and the roofs of school buildings are set apart for playgrounds in some localities. In communities which border on bodies of water, recreation piers are built which are furnished with comfortable seats, and with sand boxes and other amusements for young children.

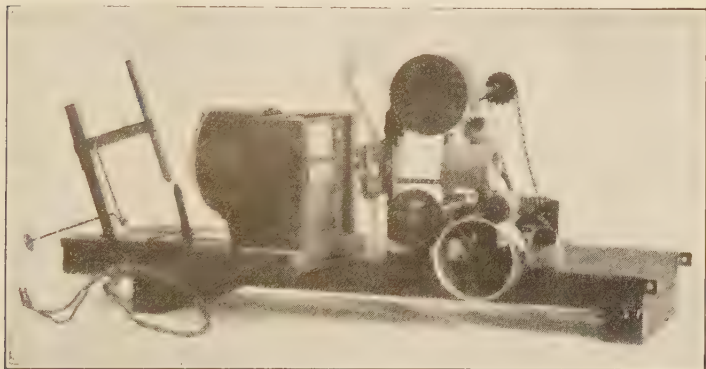
Public parks and their use. — Public parks have been

rightly called the "breathing places of a city." We know the value of green plants in giving off oxygen to the air, and in absorbing carbon dioxide from it. Many cities are provided with park systems embracing thousands of acres. Chicago, for example, has seven large and five small parks, and about forty miles of parkway connecting them. The city of New York has a system comprising 237 parks with a total of nearly 8000 acres of land. This system includes one of the finest and largest zoölogical parks in the world, three free museums of large size and several historical buildings which are open to the public. Washington, D. C., has a wonderful system of large and small parks which, combined with the museums and botanical gardens and the experimental stations of the zoölogical park, make it one of the most useful adjuncts available to public education.

The moving picture as an educational factor. — The moving picture has come to stay and may be used as an educational asset if one chooses films wisely. During the World War hundreds of thousands of young men saw educational "movies" in the huts of the Y.M.C.A. At the present time the Public Health Service, as well as manufacturing companies, have collections of free films on different educational topics. Especially important are those of the Public Health Service which show different aspects of health and disease. Is your community availing itself of the opportunity of seeing these films?

How moving pictures were invented. — The idea of taking moving pictures is credited usually to Edward Maybridge, an Englishman who, when living in California in 1872, experimented in taking a series of pictures of moving objects. The application of this idea was

worked out in the invention of Thomas Edison called the kinetoscope which was exhibited at the World's Fair in Chicago in 1893. The first real moving pictures were shown in England in 1895 by Robert Paul. Lumière & Sons invented the cinematograph a little later which was first exhibited in this country in 1896. Since that time rapid strides have been made in the moving picture busi-



First machine used to project moving pictures in America. Pictures were exhibited with this machine by Jenkins, in Richmond, Indiana, on June 6, 1894.

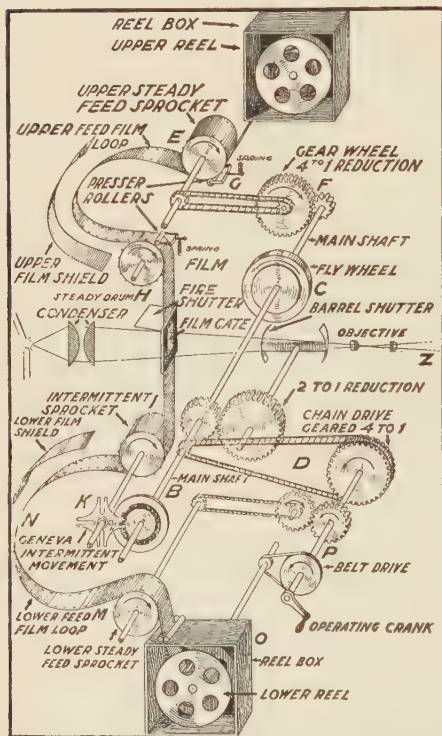
ness. Now, thousands of people are engaged in staging and manufacturing pictures, thousands more operate theaters, and between 14,000,000 and 15,000,000 people go to the "movies" every day in the year in this country, while enough film is shown each day to go almost around the globe at the equator.

How pictures are made.—A film varying in length from a few feet to five hundred feet is used in a camera which takes photographs of a moving object at the rate of sixteen to one hundred and twenty pictures a second. Negatives are developed and contact prints made on other

rolls of film. Thus many copies of the film may be made from one original negative and rented to various moving picture houses.

Projection of pictures.—There are about sixteen pictures to a foot of film. To make the pictures look

lifelike they must be run through a machine at the same rate that they were taken. Strange as it may seem, we do not see the pictures move. Each one remains still on the screen before our eyes for a fraction of a second and the light is cut off from the screen while a new picture is moved into place. The picture appears to move because of a peculiarity of the eye. Any image falling on the retina or sensitive portion of the eye remains impressed there for



Essential parts of the moving picture machine.
(After Hawkins.)

a fraction of a second after it has been removed. Since these pictures come to the eyes rapidly, the image of the preceding picture is always left on the retina until the

new image is there. Hence the pictures appear continuous and seem to move.

With the perfection of non-combustible films and the simplification of the moving picture machine, schools, social clubs, and even homes, are bound to be equipped with moving picture apparatus. They may be used to demonstrate scientific experiments or discoveries that are almost impossible to reproduce in the laboratory because of the length of time involved in preparation; the development of living plants and animals, for example, can be shown by moving pictures with the aid of animated labels or a trick device by means of which names or descriptions of the parts are run into the picture.

Religious and moral education. — Religion has played a prominent part in the development of the world. The desire to spread religion led the French and Spanish missionaries to establish missions where they had colonized. The Puritans came to Massachusetts Bay to enjoy freedom of religious worship. Since the welfare of any community is directly concerned with the morals in it, no one can object to moral instruction in the schools. We should all believe in the law "Do unto your neighbor as you would like him to do unto you" rather than the one often substituted "Do your neighbor or he will do you." A community where the Golden Rule is practiced is surely better off than one where tricksters and shysters make people suspicious of each other. A certain amount of competition is good if honest and above board. The example set by honest practices in politics and daily life may go far towards teaching young people to live straight and to look down on dirty practices in the home, in business, and in politics. Moral teaching not only does this

406 PROTECTION AND EDUCATION OF CITIZENS

but it also shows up the selfishness and greed on the part of individuals and corporations. On the other hand, it makes the employee recognize the rights of the employer. It shows that life, if it is to be worth while, is built up of "give and take" with honesty and coöperation as the corner stones.

SCORE CARD. SAFEGUARDING LIFE AND PROPERTY IN THE COMMUNITY

	100 PERFECT SCORE	MY SCORE
STREET LIGHTING Lamps lighted cloudy and moonless nights (5) No dark areas between the lights (5) Wires in business section underground (5) Lighting service well maintained (5)	20	
STREET TRAFFIC No "blind" corners (5) Traffic "cop" at congested street intersections, and at schools on streets with much traffic (10) No grade crossings (5) Traffic regulations enforced, indicated by few street accidents (10)	30	
POLICE Report neglect on part of careless citizens (5) Little or no lawlessness goes unpunished (5) Actively aid other departments (5) Efficient in detective work (5)	20	
FIRE DEPARTMENT Paid firemen on day duty (2½), night duty (2½) Hydrants, reservoirs, or natural bodies of water within 300 feet of any buildings (5) A motor chemical engine (5) A "steamer" and a "hook and ladder" truck (5) An electric fire alarm signal system (5) Strict fire laws and building regulations in business area enforced (5)	30	
TOTAL	100	

REFERENCE BOOKS

- Addams, J., *Spirit of Youth and the City Streets*. (For teachers.) The Macmillan Company.
- Articles on *Civic Advantages*. The American City, New York.
- Articles on *Safety from Fire, etc.* The American City.
- Articles on *Traffic Regulations*, Oct., 1919. The American City.

- Brown, *Health in Home and Town*. D. C. Heath and Company.
- Crocker, *Fire Prevention*. Dodd, Mead and Company.
- Crump, *Boy Scout Fire Fighters*. Barse and Hopkins.
- Crump, *Boys' Book of Firemen*. Dodd, Mead and Company.
- Crump, *Boys' Book of Policemen*. Dodd, Mead and Company.
- Finch, *Everyday Civics*, American Book Company.
- Forbush, *Young Folks' Book of Ideals*. Lothrop, Lee and Shepard Company.
- Handbook of the Camp Fire Girls*.
- Handbook Boy Scouts of America*.
- Hodgdon, *Elementary General Science*. Hinds, Hayden and Eldredge.
- Howe, *Modern City and Its Problems*. (For teachers.) Charles Scribner's Sons.
- Hughes, *Community Civics*. Allyn and Bacon.
- Jeness, *Bucket Brigade to Flying Squadron*. G. H. Ellis Company.
- Kenlon, *Fires and Firefighters*. G. H. Doran Company.
- Moffett, *Careers of Danger and Daring*. The Century Company.
- The Fire Department*. Leaflet 36, Municipal Civics. Board of Education, Newark.
- The Trial of Fire*, March, 1921; *Five Years of Fire Waste*, May, 1921. General Science Quarterly.
- Talbot, *Moving Pictures*. Heinemann.
- Town Development*. (Articles on City Improvement.)
- Trafton, *Science of Home and Community*. The Macmillan Company.
- Weeks, *The Avoidance of Fires*. (For teachers.) D. C. Heath and Company.
- Whitman. *Fire Hazards and Safeguards, 10 Lessons*. General Science Quarterly. March, 1920.
- Ziegler and Jaquette, *Our Community*. J. C. Winston Company.

PART XI. TRANSPORTATION AND COMMUNICATION

CHAPTER XXV

DEVELOPMENT OF LAND TRANSPORTATION

Problems. — 1. *To learn about the history of roads.*

2. *To learn how the development in transportation has changed our habits and customs.*

3. *To learn about different road materials.*

4. *To understand the advantages of good roads.*

5. *To understand how a load is most easily moved.*

6. *To learn how the steam engine was developed.*

7. *To learn how the steam engine works.*

8. *To learn how the locomotive is operated.*

9. *To learn the value of electricity in transportation.*

10. *To understand the types and value of bridges.*

Suggested projects. — 43. To investigate and report on the roads of my town.

44. A study of locomotives.

The development of transportation on land in the United States. — The earliest settlers in America had no way of travel except on foot. It was six years after Virginia was settled before the first horses, only nine of them, were brought from Europe. And it was a great many years later before roads began to take the place of trails. The first roads in America were built largely to help settle new territory and to aid the traders and farmers in exchanging goods. These roads followed rivers or kept close to the seaboard.

Then came the development of post roads, and soon after the close of the Revolutionary War there were 75 post offices and over 2000 miles of post roads. In 1806 Congress authorized a national road, which was completed about 1838. Soon after this, railroads came into existence, and as commodities could be carried for long distances more advantageously on them than on roads, the latter soon became largely local, centering around railroad stations and towns. This condition continued until the automobile began to be extensively used. People soon found that in order to get the best use from these new machines they must have smooth and well-made roads, therefore state and county taxes were levied on the owners of automobiles, so that a splendid system of roads is coming into existence in all parts of the United States.

Changes in transportation. — Two generations ago a New York business man who wished to go to Philadelphia

had the choice of a hazardous boat trip or a tedious two days' journey by stage coach. Today he makes that journey in comfort in a little over two

hours. In 1843 Marcus Whitman took five months to travel across the continent. To-day New York and San Francisco are less than five days apart by train, or two days by airplane. Our trains now run frequently a mile a minute, and our best expresses average fifty miles an hour, including stops, while airplanes are built that can travel over 225 miles an hour.

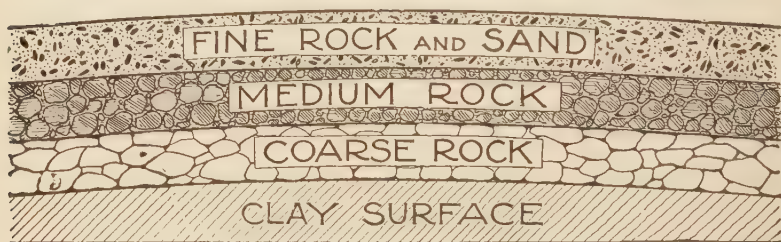
OVERLAND TO THE PACIFIC.



The San Antonio and San Diego Mail-Line

Heading of an advertising circular seventy years ago.

Road making. — The method employed by the Englishmen Telford and McAdam used most commonly in making roads in this country is as follows: First, the road is excavated to a depth of two or three feet, and several layers of large stones are placed at the bottom of the excavation. These are covered by layers of smaller stone, with layers of still smaller stones above them. The particles become gradually finer toward the top, until the surface of the road is made of a fine stone dust. The road is then covered with asphalt, tar, or bituminous



Cross-section of macadam road.

material as the binder. The road is a little higher in the middle than on the sides for the purpose of drainage.

In cities where there is much hauling of loads by horses, cobblestones of granite or sandstone, vitrified brick, or wood blocks are used. Concrete is now being employed to a great extent in our transcontinental roads, because of its durability.

Necessity of good roads. — Have you ever thought that the rural mail carriers in this country travel over a million miles of road every day in order to carry news, messages, and supplies to people who, a few years ago, were cut off from the outside world? These mail carriers travel over some of the poorest roads in our country, in

districts where agriculture is often the only industry. The farmer must have good roads in order to market his crops and to become a better citizen through contact with other people. Why do good roads save work? The manufacturer depends upon good roads and the motor truck as a means of marketing his goods in towns near his factory. In time of war good roads are of the utmost



Lincoln Highway, a transcontinental automobile road.

importance in the transportation of army supplies. Good roads and modern means of transportation have helped to make this nation a unit in thought and in patriotism almost as much as any other one factor.

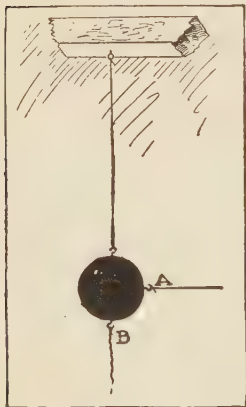
To lift a weight requires work or energy. Every time a wheel is pulled out of a hole or a rut, or it goes over a bump, a part of the load borne by that wheel is unnecessarily lifted, and energy is wasted. This kind of work is being done continually on rough roads, and requires so much additional energy that a horse or an automobile

is able to carry only part of the load that would be possible on firm smooth roads.

Demonstration Experiment. — To explain inertia.

Materials: A 5 to 7 pound weight. Thread capable of holding a 10-pound pull.

Method: (1) Suspend the weight by a thread. Connect a thread at the side *A*. Pull on this thread gently and slowly until the weight has been displaced several inches. Now bring the weight to rest. With a quick jerk, pull on the string. Is the weight moved as before? Why does the string break?



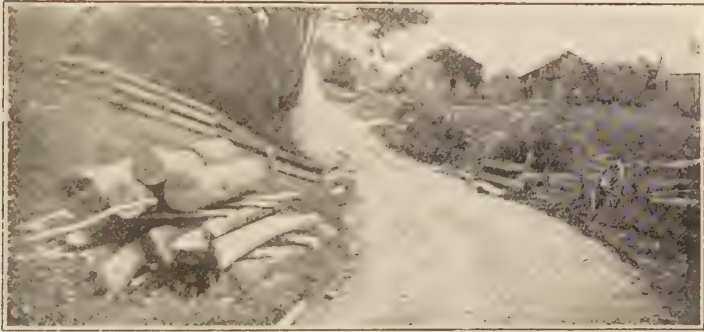
(2) With the weight suspended as before. (a) Pull with a quick jerk downward on a thread attached under the weight, at *B*. (b) Attach the thread again and pull downward with a slow, steady pull. Why does the thread break below the weight in (a) and above the weight in (b)?

Conclusion: Sum up the conclusions drawn in each part of this experiment and explain inertia of rest, which is defined as the tendency of a body at rest to remain at rest.

Application: How does the law of inertia work out in moving a heavy load on a small cart? Explain.

Drawing a load. — Do you ever wonder why it is harder to start a wagon than to move it after it is started? It requires from two to eight times as much force to start a load as it does to keep it in motion after it is started. This is due to what we call *inertia*, or that tendency of a body at rest to remain at rest, or of a body in motion to continue in motion. Extra force is required to overcome inertia, to raise a load from holes in the road bed, and to increase the speed of the vehicle. In drawing a load no matter what the motive force, it is the friction between

the wheels of the vehicle and the pavement that makes movement possible. Because of the greater diameter of a large wheel, thus giving greater leverage, less force is required to move a vehicle with large wheels on a rough road than one with small wheels. Wheels of large diameter do less



Observe the steep road partly hidden by trees in the upper picture and the gentle grade of the road in the lower picture.

damage to a road also because they revolve more slowly and pick up less of the material from the road. When an automobile or other wheeled vehicle goes rapidly over a road, a partial vacuum is produced behind the wheels, which has a tendency to pull up materials from the road bed. This continual withdrawal of dust and other small

414 DEVELOPMENT OF LAND TRANSPORTATION

particles finally loosens large fragments, and a road with its surface full of holes is produced. This shows another advantage of the slow moving large wheels.

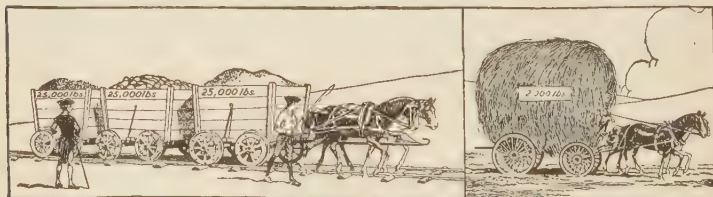
Experiment. — To illustrate the advantage of large wheels for rough and sandy roads.

Resistance due to grade. — If we think over the problem of the inclined plane (p. 193), we can see why it is that a steep grade offers more resistance than a gradual one. We are lifting against gravity.

The following table ¹ gives the amount of load (in pounds) horses can take on different pavements of different grades.

SURFACE	LEVEL	GRADE 5%	GRADE 10%
	Pounds	Pounds	Pounds
Asphalt	13216	—	—
Broken stone, best condition	6700	1840	1060
Broken stone, slightly muddy	4700	1500	1000
Broken stone, ruts and mud	3000	1390	890
Earth, best condition	3000	1500	930
Earth, average condition	1400	900	660
Stone-block pavements, dry and clean	8300	1920	1090
Stone-block pavements, muddy	6250	1800	1040
Sand, wet	1500	625	390
Sand, dry	1087	445	217

The use of rails in transportation. — The first methods of transportation made use of roads with stone or earth



Comparison of loads which can be drawn by horses on dirt roads and on rails.

foundations, but in 1630, wooden rails were used, as it was found much larger loads could be pulled along such tracks.

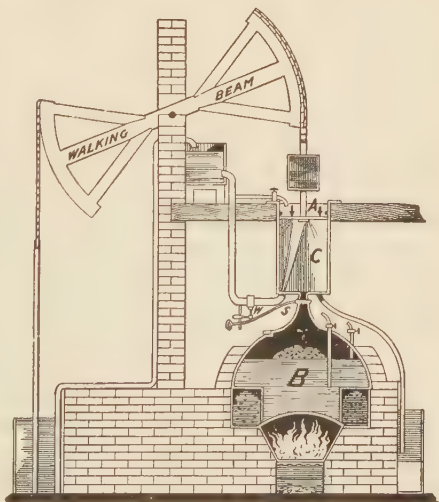
¹ Table from Highway Construction, Byrne, Am. Tech. Soc.

Iron rails were introduced in 1737 for carrying coal in England. In about 1800, a flanged iron wheel was employed in connection with the rails, and by this, more work could be done, for ten horses could draw on this road as much as four hundred horses on an ordinary street.

The first steam engines. — So far as we know, Hero of Alexandria, about one hundred and fifty years before Christ, contrived a toy in which steam caused a ball to revolve, but it was a great many centuries later that steam was actually put to practical use.

Experiment. — To discover the principle of the first steam engine.

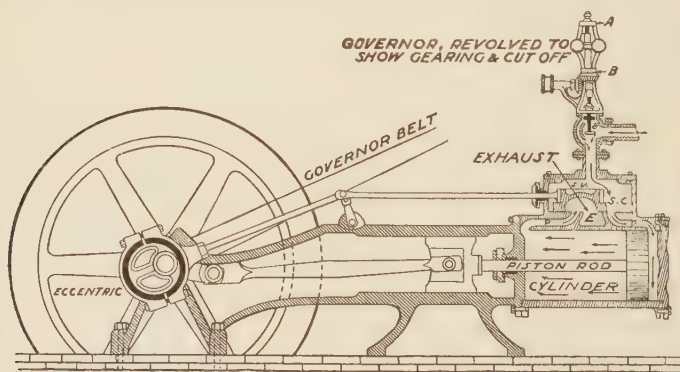
The steam engine was not the work of any one man but the result of a great deal of experimentation by many men. Denys Papin, a Frenchman, made the first model of a steam engine with a piston of which we know. This principle was developed by Savary, a Cornish miner, who made the first useful engine. In 1710, Newcomen, who was an English iron worker, completed an improved engine. His engine had a piston which was raised by steam pressure. The steam was condensed in the cylinder



The Newcomen Engine. When valve *S* is open, steam from *B* pushes the piston up; when *S* is closed and *W* is open a jet of water condenses the steam and the atmosphere pushes the piston down.

C by a jet of water (see figure), thus reducing the pressure. This allowed atmospheric pressure at *A* to push the piston to its original position. The power was transmitted from his engine to a pump by means of a walking beam.

Watt's engine. — Half a century later James Watt was asked to repair a model of the Newcomen engine used for demonstration in Glasgow University after London mechanics had failed to make it work. Watt became greatly interested, and as a result of his study, the modern engine with its slide valve and piston was invented in which the principle was practically the same as the modern steam engine.



A steam engine. Study the working parts. Can you explain how the governor cuts off the supply of steam?

Demonstration Experiment. — Demonstration of steam engine model.

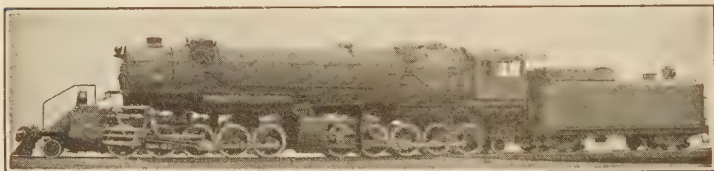
Materials: Steam engine model.

Method: Turn the fly wheel until the slide valve is in position to admit steam first on one side of the piston head and then on the other. Make two diagrams of the cylinder and steam chest to show these two positions of the piston and slide valve. Examine the eccentric to see how it works and explain its purpose.

Watt's improvements were these: first, he kept the cylinder hot all the time instead of having it alternately heated and cooled; second, he had steam pushing the piston on both of its strokes instead of one only; third, he regulated the flow of steam to the cylinder so that the steam from the boiler was cut off when the piston had made one-fourth of its stroke, which more than doubled the efficiency of the engine, the added work coming from the expansion of the steam; fourth, he used oil for lubrication and to keep the steam from escaping around the working parts.

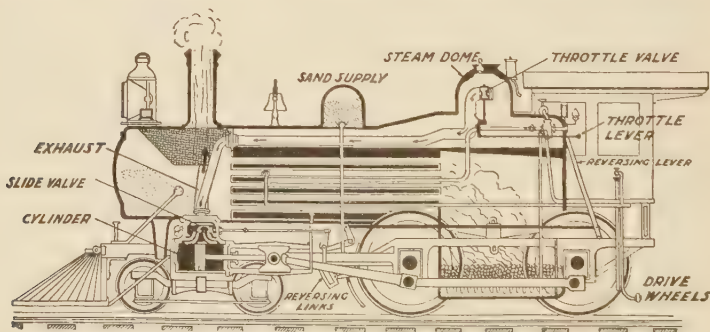
The steam engine of to-day. — The steam engine in use to-day has some improvements on the one made by Watt. Steam generated in the boiler enters the steam chest and then passes alternately through two openings into the ends of the cylinder, first on one side and then on the other of the piston. The entrance of steam into the cylinder is controlled by the slide valve, which is moved by an eccentric placed on the shaft of the fly wheel of the engine. Steam entering at one end of the cylinder pushes the piston in one direction; and when entering at the other end pushes it back again. Two devices give it an even and a regular motion. These are the fly wheel and the governor. The fly wheel, by its momentum, prevents a slowing up of the engine when the load is suddenly increased. The governor automatically regulates the supply of steam entering the steam chest. This is done by the centrifugal action of the balls of the governor (*A B* in diagram). As the speed at which these balls rotate increases, they swing outward and partly close the steam valve which causes the engine to slow up a little. The balls revolve less rapidly, and more steam is allowed

to come in. These two opposing actions soon become adjusted so that an even speed is maintained.



Which of these engines is for speed and light loads? Which for heavy loads and slow traffic? How do you know?

The locomotive engine. — Complicated as the locomotive is, the principle of Watt's engine can still be applied



Essential parts of the locomotive. Locate the piston and boiler.

to it. If you mount an engine, a boiler, and a furnace on wheels, you have a locomotive. You will notice that freight engines which draw heavy loads have smaller

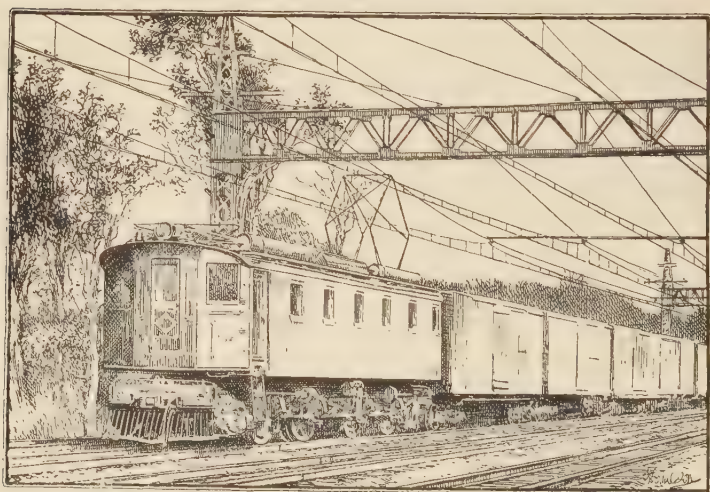
driving wheels, than passenger engines which are built for speed. Can you see why there should be this difference?

The development of railways in the United States. — The first locomotive to be operated in America was the Stourbridge Lion, imported from England, and run August 8, 1829. The first railroad in the United States was built from the granite quarries in Quincy, Massachusetts, to the coast in 1826. This road was only four miles long, and the cars were hauled by horses. The first locomotive built in America for practical service was called the "Best Friend." The first railway opened to the public was operated in Charleston, South Carolina, and the train was drawn by the "Best Friend," which was not considered a "best friend" by all the passengers, for it belched out black cinders and live sparks, setting fire to their umbrellas and clothes. By 1835 800 miles of railroad had been built in the United States. By 1861, there were 30,000 miles, while at the present time there are probably about 250,000 miles of railway with 90,000 locomotives, 60,000 passenger cars, and nearly 3,000,000 freight cars. Even this equipment fails to meet the needs of transportation.

The replacing of steam by electricity. — In many parts of the country electricity is taking the place of steam power to propel locomotives. Steam locomotives are not very efficient in their use of coal, as it takes a large amount of coal to furnish the necessary power. In some parts of our country, coal is not as easily obtained as is water power. Water power can be harnessed to produce electricity by means of great dynamos, and as it is usually abundant where railroads have to go up heavy grades it is much cheaper than coal. In many parts of the West,

railroad systems have been, or are now being, rapidly furnished with electric power.

Electric railways. — Those who live in large cities can appreciate better than others what the “electrics” mean to hundreds and thousands of people who depend upon them for their daily use. This is especially evident when a tie-up occurs in the street railway traffic during



A modern electric locomotive.

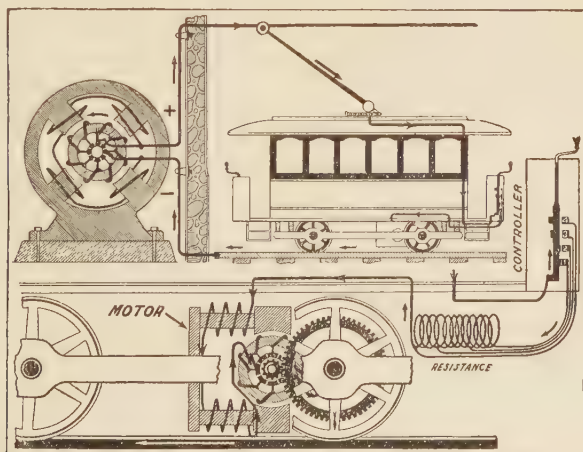
rush hours. Electric cars have become necessities in every large community. In 1884 public electric railways were first in operation in Providence, Rhode Island, and in Kansas City. When we realize that to-day thousands of towns and cities are equipped with complete electric railway systems, and that thousands of other towns are connected by suburban lines, we appreciate what the development of electricity has meant in these recent years.

The electric car circuit. — Electricity is conducted from the dynamo in the power station to the trolley wire



Edison's first electric locomotive.

and thence through the trolley to the electric motors beneath the car and through a number of controlled



Trace the trolley car circuit from power house dynamo to trolley, controller, motor, through car wheels to rails and back to the dynamo.

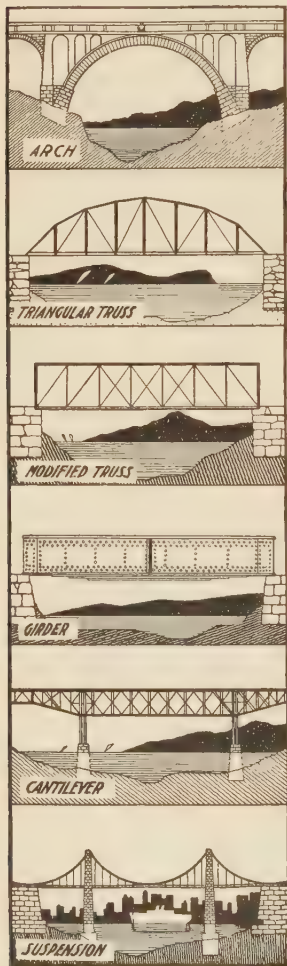
resistances. The motorman by moving the controller handle determines just how much resistance is to oppose

the electricity, and thus he regulates the amount of current which passes through the motor. The current passes from the motor through the wheels of the car to the rails

and is conducted back to the dynamo in the power house by the rails and ground, thus completing the circuit.

Bridges and their part in transportation. — Only in civilized times have bridges come into existence. Primitive peoples when traveling used to ford streams, or if they were too deep crossed by boats. The Romans were bridge builders of the stone arch type. But with the coming of steam and electric railways, bridges have a much greater importance.

The principles on which bridges are made. — A very simple bridge is often seen on country roads. Logs, or perhaps iron beams, are placed across the brook, the ends resting on solid piers. This is known as a *girder* bridge. Such bridges do very well for a short span, but where a long distance must be covered, a bridge must be built so as to hold the load without using such heavy beams. A study of the



Types of bridges.

diagrams shows how this is done by means of what is called the *truss* bridge. When still greater distances have to be connected the principle of the *cantilever* is used. Other types of bridges with which we are familiar are the *arch*, built of stone or steel, and the *suspension*. The last named is the most graceful bridge of all. A familiar example of the arch is the new Hellgate bridge in New York, while one of the most beautiful suspension bridges in the world is the old Brooklyn bridge spanning the East River.

REFERENCE BOOKS

- Articles on *Good Roads*. The American City.
Articles on *Transportation*. The American City.
Corbin, *Mechanical Inventions of Today*. Seeley, Service and Company.
Corbin, *The Marvels of Scientific Inventions*. Seeley, Service and Company.
Earle, *Home Life in Colonial Days*. The Macmillan Company.
Farmer's Bulletin 338, *Macadam Roads*. U. S. Dept. of Agriculture.
Forman, *Stories of Useful Inventions*. The Century Company.
Gregory-Keller-Bishop, *Physical and Commercial Geography*. (For teachers.) Ginn and Company.
Hall, *Wonders of Transport*. Dodge Publishing Company.
Holland, *Historic Inventions*. Jacobs and Company.
Howden, *Boys' Book of Locomotives*. Grant, Richards, London.
Modjeski, *Bridges — Old and New*. General Science Quarterly, Nov. 1922.
Moffett, *Careers of Danger and Daring*. The Century Company.
Municipal Year-book, *Transportation*. City of New York.
Page, *Roads, Paths, and Bridges*. (For teachers.) Sturgis and Walton.
Portland Cement, *Roads, Concrete and Cement*. 6 pamphlets. Philadelphia, 1915.
Rocheleau, *Great American Industries; Transportation*. Flanagan and Company.
Smith and Jewett, *Introduction to the Study of Science*. The Macmillan Company.
Thompson, *Concrete in Highway Construction*. Atlas Portland Cement Company.
Trafton, *Science of Home and Community*. The Macmillan Company.
Warman, *The Story of the Railroad*. D. Appleton and Company.
Wilkinson, *Practical Agriculture*. American Book Company.
Williams, *How to Make Things*. Sully, Kleinteich, N. Y.
Wright, *Stories of American Progress*. Charles Scribner's Sons.

CHAPTER XXVI

THE AUTOMOBILE AND GAS ENGINE

Problems. — 1. *To learn about the early development of the gas engine and the automobile.*

2. *To understand how power comes from gas.*

3. *To learn how the four-cycle engine works.*

4. *To understand the value of such accessories as the carburetor.*

5. *To learn how gasoline is fed from the tank into the engine.*

6. *To learn how kerosene may be substituted for gasoline.*

7. *To learn about the uses of tractors.*

Suggested project. — 45. *To become an efficient automobile caretaker.*



An English horseless carriage in 1833.
Operated by steam.

Early development of the gas engine. — As early as 1680, Huyghens, an astronomer, showed that an engine could be driven by exploding gunpowder in a cylinder, the resulting pressure being used against

a piston. A hundred years later, an Englishman, Robert Street, suggested that turpentine might be used in place

of gunpowder. In the early part of the nineteenth century, two Frenchmen made engines which used gas instead of steam, but none of these attempts were put into practical use, the first real gas engine being devised in France in 1862. This gas engine, called an internal combustion engine, was the forerunner of the modern automobile engine.

The development of the automobile. — It seems hardly possible that the first motor cycle was not made until 1886, and it was almost ten years later before automobiles began to be seen on the streets. The first automobile race in this country was held in 1895 in Chicago, and there were only two contestants, one of which broke down, while the winner could make only seven miles an hour. Before 1900 there were practically no automobiles in actual use in the United States; to-day there are over 10,000,000 motor vehicles of different kinds registered. A speed of about two hundred miles an hour has been attained in racing, and in some parts of the country motor trucks are taking the place of railroad trains for rapid transportation of freight.

How we get power from gas. — The fuel for the internal combustion engine, whether liquid or gas in its natural state, must be in the form of a gas when it enters the engine cylinder. Gasoline, kerosene, and alcohol are three liquids which can be vaporized easily, and therefore are suitable fuels for the gas engine. Alcohol is too expensive, however, for common use. Kerosene finds limited use in slow speed engines. Gasoline vaporizes readily and is the fuel most commonly used. When the vapor is mixed with the right amount of air and lighted it explodes and the burning gas generates heat. This heat expands the



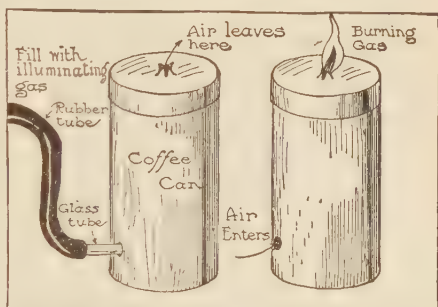
The automobile monopolizes our streets to-day. Typical street traffic in the city of New York in 1836, 1886, and 1921. Notice also that three periods of lighting are shown by the street lamps, oil, gas, and electric. Telephone poles are shown in the 1886 picture. Why not in the other two?

gases in the cylinder of the engine, drives the piston, and thus gives power.

Demonstration Experiment. — To show explosive and non-explosive mixtures of gases.

Materials: Test tubes. Illuminating gas. 1-pound coffee can with a hole $\frac{1}{8}$ inch in diameter in the cover and another similar hole in the side of the can 1 inch from the bottom. Test tubes. Rubber bands.

Method: A. Measure off on 5 test tubes lengths from the closed end to represent 5 %, 10 %, 15 %, 20 %, 25 %, of the total length, respectively. Mark these positions with rubber bands about the tubes. Fill tubes with water. Let illuminating gas enter tubes to fill them respectively with 5 %,



10 %, 15 %, 20 %, 25 %, of gas. Then take each in turn, let the water run out and air enter. Close the tube, invert and shake to mix the air and gas thoroughly. Bring a lighted match to the mouth of the tube, to test for an explosive mixture.

B. Put the cover tightly on the can. If the cover is loose, make it tight with paper. Fill completely with illuminating gas. Apply a flame to the hole in the cover and allow the gas to burn as long as it will. Note all changes in the flame. As the gas burns what is entering the can through the hole on the side? Do not be in a hurry to touch the can if the flame appears to die out and disappear.

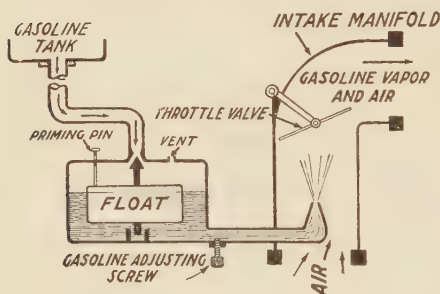
Results and Conclusion: What are the results in A? in B? What can you say in regard to "explosive limits of gas-air mixtures"? Explain changes in the flame and the final result observed in B.

Application: Can gasoline be substituted for the gas? Would the results be better with warm or cold tubes and can? Why?

An explosive mixture. — Experiments with illuminating gas and air show that the proportion in which the two are mixed is very important in producing an explosive mix-

ture as not all mixtures will explode. The range of explosive mixtures of illuminating gas and air is from 93% air and 7% gas to 80% air and 20% gas.

The carburetor. — All automatic engines have a device called the carburetor in which a liquid fuel is vaporized



The carburetor.

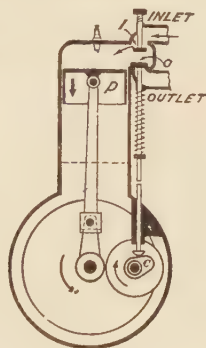
and mixed with air, making it ready to enter the engine. If gasoline is sprayed into the air, no liquid will be seen as it immediately vaporizes and mixes with the air. The oxygen of the air is needed in burning the gasoline,

and if properly mixed an explosive charge is produced. If too much gasoline or too much air is present, the mixture will not explode. The carburetor requires rather delicate adjustment in order to produce a proper explosive charge. The explosive charge passes from the mixing chamber or intake manifold of the carburetor through an inlet valve into the engine cylinder at the proper time.

The four-cycle gasoline engine. — The two forms of engines found in use are the two-cycle and the four-cycle types. The two-cycle has one power stroke for each revolution of the fly wheel. Each of these revolutions involves two strokes of the piston, hence there is but one power stroke in two strokes of the piston. The four-cycle engine is the simpler of the two and is the one in common use. The operation of the four-cycle engine will now be explained by describing what happens in each of the four

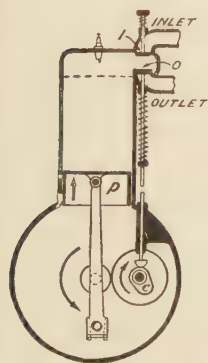
strokes. A careful study of the diagrams showing four different strokes will help us to understand how this engine works.

The suction stroke or charging stroke. — Let us start with the piston in the cylinder (see *A*) just starting to move out. As the crank revolves through half a circle the piston will move downward. During this stroke valve *I* is open but valve *O* remains closed. A mixture of air and gasoline vapor, sometimes called “the charge,” is brought into the cylinder from the mixing chamber of the carburetor by “suction.” Is it pulled or pushed in?



A. Suction stroke.

At the end of this stroke valve *I* closes and we have the condition shown in (*B*), the cylinder being filled with an explosive charge of air and gasoline.

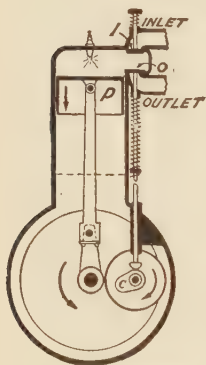


B. Compression stroke.

The compression stroke. — During the next half revolution of the crank, the piston is moving into the cylinder. Both valves *I* and *O* are closed. The charge is compressed into the clearance space above the dotted line. As the volume of the gas decreases its pressure rises and its temperature increases. The pressure at the end of the compression stroke may be as high as 100 to 200 pounds per square inch and its temperature 300° to 700° F.

The expansion stroke or power stroke. — When the gas is under this high pressure and the piston is just ready to start outward again, an electric spark in the spark plug

ignites the charge. The fuel now explodes and great heat results. The temperature is raised to over 3000° F. The

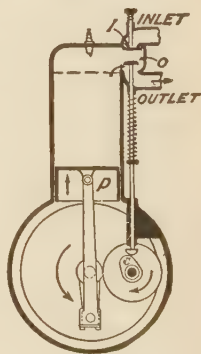


C. Power stroke.

heat tends to cause expansion, but in the confined space effects tremendous pressure. This pressure, amounting to 300 to 700 pounds per square inch, is exerted during the entire stroke. This is often called the power stroke because it is the only stroke which receives power from the fuel.

Exhaust stroke. — At the end of the expansion or power stroke the cylinder is full of burned gases. As the piston starts back valve *O* opens, allowing the burned gases to be forced out. At the end of this stroke valve *O* closes while *I* opens, and the engine is ready to begin the suction stroke again.

Use of flywheel. — Since force is exerted upon the piston during only one of its four strokes, we would have very jerky motion were it not possible to carry some of this energy over to the other strokes. This is done by communicating the force to a heavy flywheel which is set in motion. The momentum thus given to the flywheel makes it a storehouse of energy for the other three strokes.



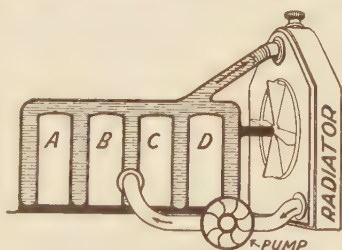
D. Exhaust stroke.

Experiment. — To explain momentum.

Cooling the cylinder. — Much of the heat resulting from compression and from combustion of the charge is absorbed by the cylinders. Unless this heat can be taken

away as fast as it is received and the cylinders kept at some temperature below that at which the gas will burn, there will be a premature explosion or "back firing." Suppose the charge were ignited by a hot cylinder just before the end of the compression stroke. What would be the result?

Air-cooled engines. — There are two systems of cooling, — by air and by water. The amount of heat given off by a hot body increases with the area of radiating surface. By making gas engine cylinders with flanges or by studding the surface with metal projections, the amount of heat conducted to the air and radiated is increased. By bringing in cold air and driving the warmed air away faster than it would go in natural circulation, cooling is hastened. This is done in air-cooled automobiles by means of a fan.



A, B, C, D = CYLINDERS
Water-cooling system of an automobile engine.

Water-cooled engines. — When water is used for cooling, a water jacket surrounds the explosion chamber of the engine. Through this, water is kept in circulation sometimes by gravity, but better by means of a pump driven by the engine. In the automobile the hot water leaving the water jacket is carried through a radiator where it is cooled rapidly. A fan helps circulate the air around the passages of the radiator. By this means a relatively small amount of water is sufficient to keep the engine cool.

How the charge is ignited. — In practically all gas engines to-day an electric spark sets off the charge in the

cylinder. There are two systems of ignition: the "jump" spark and the "make-and-break" spark.

Demonstration Experiment. — To see the difference in method of producing the "jump" spark and the "make-and-break" spark.

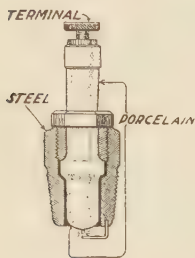
Materials: A spark coil. An induction coil. A spark plug. A key or switch.

Method and Results: (1) Connect poles of secondary coil of the induction coil to the spark plug. Send a momentary current from 2 dry cells into the primary coil of the induction coil. This shows the "jump" spark.

(2) Connect 2 dry cells in series with a spark coil, leaving a gap in the circuit. Bring the two wires at this gap as close together as possible without touching. Is there any spark? Touch the two wires and break the circuit instantly. Is there any spark? This results from a "self-induced" current. Can you find out what this means?

Application: Can you see any advantage in the "jump" spark for automobile use?

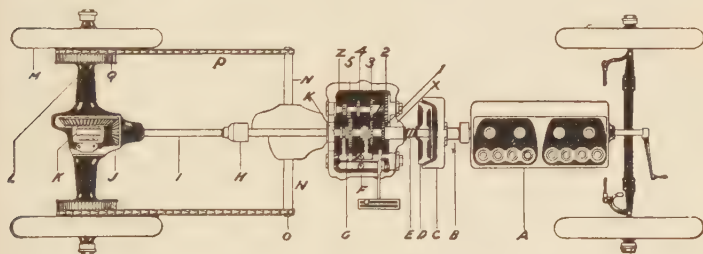
The jump spark is used in high speed engines such as are found in the automobile and airplane. The spark jumps the gap between the wires at the end of the spark plug which is screwed on to one end of the engine cylinder. The make-and-break spark is used in low speed engines such as are found on motor boats.



A spark plug.

How the spark is produced. — An electric spark can be produced only by a high voltage current. Both dry cells and storage batteries give a low voltage current. It is possible to "step up" a low voltage to a high voltage by means of either a *spark coil* or an *induction coil*. In some cases a magneto is used. The magneto is an electric generator which produces a high voltage current and replaces both batteries and coils.

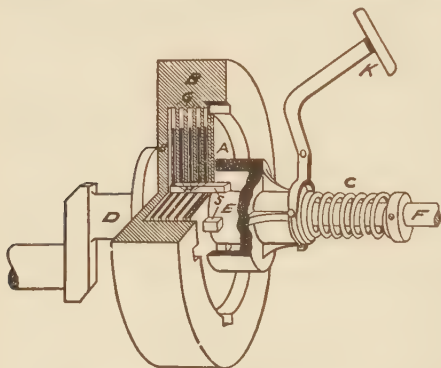
Transmission. Before an automobile can move, the power developed in the engine must be transmitted to the wheels. This is usually done by what is called the "*shaft drive*," but sometimes, particularly in trucks, by the "*chain drive*." The differences in methods employed in the two types are shown in the illustration. The fly wheel of the engine (C in figure) is the outside or driving



Automobile transmission systems.

member of the clutch and revolves when the engine is running. When the clutch spring (E) is released, the inner member of the clutch is pushed into C so tightly that both C and D revolve together. A shaft from D passes into the transmission case F, where by various gears, different powers or speeds may be applied to the propeller shaft which runs from the transmission case to the rear axle. Here the power is given to the driving wheel. If a "*chain drive*" is used the propeller shaft (I) and differential (K) will be replaced by the chain, axle, and differential indicated by O, N, P in the diagram. Many automobiles use a *multiple drive clutch* instead of a *cone clutch* shown in the figure referred to above. This type of clutch is shown in the figure on page 434. Attached to the inside of the flywheel (B) are a number of driving disks;

alternating with these are driven disks which communicate the power by means of the shaft *F* to the transmission gears. The spring *C* holds the driven disks firmly against the driving disks and engine power is carried to *F*. But when the foot presses on the pedal *K*, spring *C* is



The multiple drive or disk clutch.

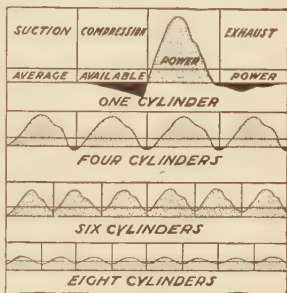
compressed and the driven disks are pulled away from contact with the driving disk, allowing the engine to run freely without communicating power to the shaft *F*.

The muffler. — As the burned gas leaves the engine cylinder,

it is at a pressure much above that of the atmosphere. If allowed to discharge directly into the air at this high pressure it gives a very loud and objectionable explosive sound. The muffler is a device to reduce the noise. By leading the gases from the engine into a series of chambers, each one larger than the one previously occupied by them, the gases expand gradually and finally escape at a pressure but little above that of the atmosphere.

Engines of many cylinders. — A single large cylinder used with a heavy flywheel will do satisfactory work for many purposes. For automobiles, however, it is desirable to have at least four cylinders. The four piston rods all turn the same main shaft. But the explosions occur at different times, so that during each one of the four strokes of the piston there will be a power stroke in one of the

cylinders. By this means each explosion is smaller and a lighter flywheel may be used to give a steady motion. Automobile engines are built with four, six, eight, and twelve cylinders. The power may or may not increase with the number of cylinders, and the greater evenness obtained from the twelve-cylinder engine is of but little advantage over that obtained from the six cylinders, since there are so many more parts to move.



Showing the greater evenness of power distribution as the number of cylinders is increased.

An age of automobiles. — Thanks to the low-priced and excellent engines now on the market, a person need not be wealthy to own a motor cycle or a motor car. Millions of pleasure cars are now operated, while commercial cars



The caterpillar tractor is useful in war and in peace.

and motor trucks have come into much greater use since the World War. A period of activity in the construction of good roads is favorable to the increased use of automobiles.

Tractors and their uses. — In late years the gas engine has come into prominence on the farm, where it does better and more economically the work of cultivating, reaping, binding, and thrashing, than was done formerly by horses. Most large farms now use the gasoline engine in many ways. The war made use of tractors, not only in dragging heavy guns and supplies, but also in that interesting development of modern warfare known as the tank. The tank or so-called caterpillar tractor became an important weapon of offense; went over the roughest kind of ground, tore up barbed wire entanglements and even passed through heavy embankments and walls of masonry.

REFERENCE BOOKS

- Baker, *Boys' Book of Inventions*. Doubleday, Page and Company.
Burns, *The Story of Great Inventions*. Harper Brothers.
Collins, *Keeping Up with Your Motor Car*. D. Appleton and Company.
Cressey, *Discoveries and Inventions of the Twentieth Century*. E. P. Dutton Company.
Darrow, *The Boys' Own Book of Great Inventions*. The Macmillan Company.
Doubleday, *Stories of Inventors*. Doubleday, Page and Company.
Dyke, *Motor Manual*. (For teachers.) A. L. Dyke, St. Louis.
Hodgdon, *Elementary General Science*. Hinds, Hayden and Eldredge.
Maule, *Boys' Book of New Inventions*. Grosset and Dunlap.
Page, *The Modern Gasoline Automobile*. Henley and Company.
Rolt-Wheeler, *The Wonders of the War on Land*. Lothrop, Lee and Shepard Company.
Smith and Jewett, *Introduction to the Study of Science*. The Macmillan Company.
Trafton, *Science of Home and Community*. The Macmillan Company.

CHAPTER XXVII

TRANSPORTATION BY WATER

Problems. — 1. *To learn how water transportation began and developed.*

2. *To understand why things float.*

3. *To learn how steam was successfully applied to drive boats.*

4. *To understand how submarines are managed.*

5. *To know the principal water trade routes of the world.*

Suggested project. — 46. To become a skilled motor boat operator.

Development of water transportation. — Long after the land was used as a means of transportation, primitive man must have developed the idea of going over streams or bodies of water on logs or other floating objects. It was a long step to the hewing down of a tree and cutting a canoe out of a log, and a still longer one before large vessels such as the triremes and galleys of the Romans and Greeks were developed. Later men began to use the wind for locomotion on the water, but they still used oars when winds were unavailable. The Middle Ages saw the development of sailing vessels and Spain's and then England's supremacy on the sea. It was centuries after the discovery of the new world that the application of steam was first made in the clumsy inventions of Fitch and others who used it to move a number of oars or paddles.

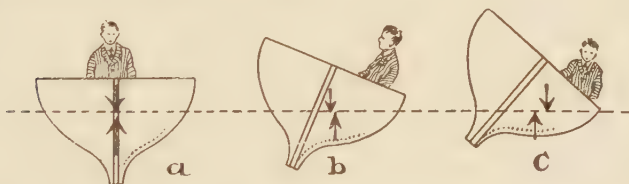
Then came Fulton's triumph with a paddle-wheel boat. To-day the ocean liner is moved by turbines turning one or even four screws which propel vessels over 900 feet long. One hundred and fifty years ago a month was considered good time for a sailing vessel to make the trip between England and this country. Our best liners make this distance now in about five days.

Why things float. — A great many years ago the famous old mathematician, Archimedes, is said to have discovered the significance of what we call *density*. The story goes that King Hiero of Sicily had a crown made by one of his goldsmiths which he suspected did not contain pure gold. He asked Archimedes to discover if the crown had been made of mixed metals, but would not allow him to bore into it or mar it in any way to find out. The philosopher, while taking a bath one day, noticed that his body displaced a certain amount of water, and seemed to be buoyed up by it. He was so impressed by this that he applied the idea to the crown, and thinking that he had found the solution of this problem, he rushed philosopher-like, from his bath without thinking of clothes, and ran down the street crying, "Eureka! Eureka!" which means, "I have found it! I have found it!" He had really found the solution of his problem. By weighing the crown in the air, and then in water, he found how much it lost when weighed in water. This loss was due to the buoyancy of the water and was equal to the weight of water displaced. The volume of the water displaced was of course the volume of the crown. The weight divided by its volume gave its density, since density is the weight of a unit volume. The density of pure gold being known it was an easy matter to compare the density of the crown

with that of pure gold and to detect any fraud of mixing lighter metals with the very heavy gold. The principle of buoyancy thus discovered is stated, "*A body immersed or floating in a fluid is buoyed up with a force equal to the weight of the fluid displaced.*"

Experiment. — To see how much water a floating body displaces (volume and weight).

Buoyancy and stability. — When we say a substance is *buoyant* we simply mean that it is lighter than the same bulk of water, and therefore floats. The force which water exerts in holding up the weight of a body, no matter whether



The lower arrow represents buoyant force, the upper arrow, gravity force. In *a* these are in the same vertical line and the boat is in stable equilibrium. In *b* and *c*, the boat is shown in unstable equilibrium. What will be the next movement of the boat in *b*? in *c*?

this weight sinks or remains on the surface, is called the *buoyant force* of water. This is equal to the weight of the water displaced. We all know the danger of being careless in a canoe and that if we lean too far on one side or raise the body too high above the surface of the water, we may suddenly upset. The reason for this is that we have changed the positions of both the *center of gravity* and the *center of buoyancy*. The center of gravity of a body is a point in that body about which the entire mass seems to be centered. The center of buoyancy is the center of mass of that part of a body which is below the water line or it is the center of the space from which water is displaced.

When a person sits close to one side of a boat that side sinks deeper into the water and the center of buoyancy is shifted toward that side. The center of gravity of the person and the boat also moves toward the side. If the new center of gravity is between the new center of buoyancy and the keel, the boat will become stable, but if it is between the center and the side of the boat it will upset. (See page 439.) A high center of gravity will cause an upset quicker than a low center of gravity. Can you tell why? Boat builders in order to keep the center of gravity low add a keel weighted with lead, take on a heavy load of ballast, or fill tanks with water close to the bottom of the boat.

Experiment. — To explain center of gravity and center of buoyancy.

Rowing. — The first power device used in water transportation was probably a pole. Then came the paddle.

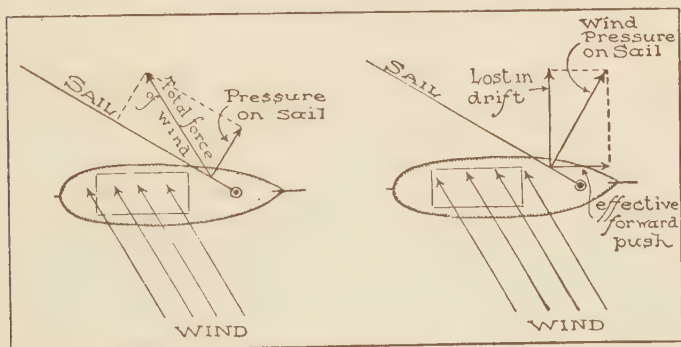


Explain lever action here.

We have read of the wonderful skill of the North American Indian with his light birch bark canoe. But since the paddle would not do for heavy loads oars came into existence. An oar is used as a lever, applied

at the oarlock to the weight to be moved, while the blade of the oar acts as a fulcrum. A stroke against the water pulls the boat forward a little, the oar, lifted from the water, is carried back through the air where there is little resistance, and another pull on the oars brings the boat forward again.

Sailing. — With an understanding of the laws of physics came the use of sails. When the wind meets a sail at right angles its full force tends to move it. When the angle between the wind and the sail is oblique a part of the wind spills over the side so that only a portion of the force of the wind is effective in moving the boat. By shifting the sail and letting the wind work on one side and then on the other and thus making a zigzag course



With the wind obliquely ahead, one component of the wind's force may be used to drive the boat ahead. The wind's pressure on the sail is a fractional part of its total pressure, and the effective forward push given to the boat is but a part of the wind's pressure on the sail.

it is possible to sail against the wind. This is known as "tacking."

Use of steam. — In the latter part of the eighteenth century, men began to experiment with steam as a motive power for boats. The small boat made by Fitch and rigged with paddles and an engine went through the water at the rate of seven and one-half miles an hour, but it was Robert Fulton who made the first serviceable steamboat.

Rapid development of the steamship followed, so that by 1858 there was a record breaking ship for size in the

Great Eastern, a boat 692 feet long, 83 feet wide, and 58 feet deep. She was driven by paddle wheels and propellers, and rendered great service in laying the first transatlantic submarine cable. Unfortunately she was so far in advance of her time that she was not a success commercially. At the time of the Civil War, iron was first employed in the making of ships' hulls, and now steel has come into extensive use and even concrete is used occasionally. The modern greyhounds, such as the *Aquitania*, the *Olympic*, and the *Majestic*, the latter the world's largest ship, give

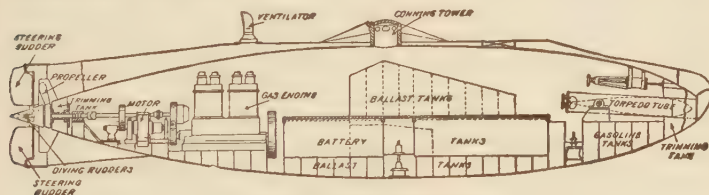


A modern ocean liner.

one some idea of the way transportation by water has developed. They have two, three, or four screw propellers, which enable more rapid turning in a limited area. The steam engine, too, has taken wonderful strides. The latest type is the so-called steam turbine, which was first used by Sir Charles Parsons in 1897. With this type of engine, a speed of forty miles an hour is obtainable as against twenty-five or thirty miles with an ordinary steam engine. One serious disadvantage of the turbine is that it cannot be reversed, so that separate turbines have to be made for reversing the ship.

Electricity as a motive power. — One interesting development which is being applied to our latest battleships is the attachment of the turbine to electric generators which drive motors that turn propellers. Reversal of the electric motors does not interfere with the working of the turbine, and very rapid manipulation of a ship is thus obtained.

The submarine. — The World War brought the submarine into prominence, and caused its rapid development. A submarine is made so that its weight is a little less than that of its own volume of water. Along its sides are numerous air-tight tanks. Water is admitted to these



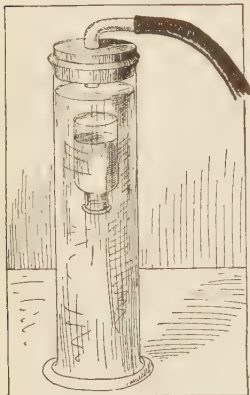
Section of Holland submarine.

tanks and forced from them by the use of compressed air. In this way the boat may be made to sink to any depth and come to the surface again. By use of horizontal rudders the boat can be made to dive or come up, depending on the way in which the rudder is operated. When on the surface, the submarine usually employs a Diesel oil engine and during this time it generates electricity for a large number of storage batteries. When under water it moves by means of the power stored in these cells which also furnish current for lighting. Some of the German submarines captured in the late war were over 300 feet long, and submarines planned for our navy before the Disarmament Conference was called were to be even longer than these.

Demonstration Experiment. — To show how the submarine may rise and sink in water. (Cartesian diver.)

Materials: A glass cylinder fitted with a 1-hole stopper. Glass and rubber tubing. A pill vial.

Method and Result: Pass a 3-inch length of glass tubing through the stopper. Attach rubber tubing to the glass tube. Fill the cylinder



nearly full of water. Fill the vial $\frac{1}{3}$ full of water and drop it mouth downward into the water. If it sinks, remove enough water from the vial so that it will just float. Close the cylinder with the stopper and blow through the tube. If the vial does not sink add a little more water to it. Change the amount of water in the vial until it is so adjusted that upon blowing into the closed cylinder the vial sinks and upon releasing the pressure it rises. Watch carefully the change in water space and air space in the vial.

Conclusion: How would you account for the sinking and rising.

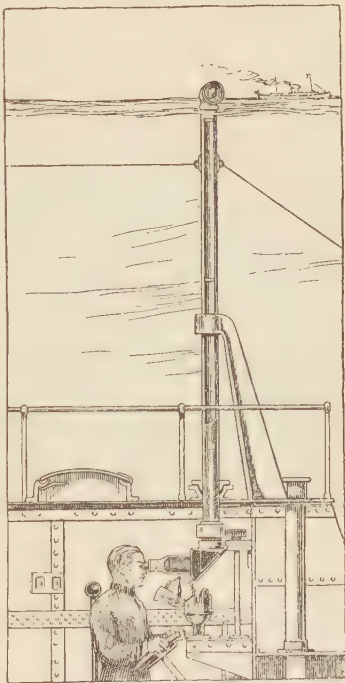
Application: Explain one way for making a submarine sink or rise in water.

The periscope. — Another invention which made the submarine the dangerous menace that it was is the *periscope*. A study of the diagram shows how this periscope is used. Light from objects on the surface is transmitted through this instrument by an arrangement of lenses and mirrors, so that the person at the wheel of a submarine can see all that is taking place on the surface, and the torpedo can be directed toward its mark.

Ocean trade routes. — A study of a trade route map shows that the principal pathways on the Atlantic Ocean run from England or continental ports chiefly to New York, and a few to Boston and Canadian ports. Other routes extend to South America around Cape Horn and

the Cape of Good Hope, while in the Pacific Ocean the chief trade routes are from San Francisco to Japan, Australia, and New Zealand, and to the East Indies and Philippine ports. The opening of the Panama Canal with its enormous locks and electric towing system has made important changes in trade routes from the Atlantic to the Pacific ports. Much time is saved, especially in going from England to San Francisco, Japan, and Australia.

Seasonal changes in trade routes. — Since the ocean is free to the world, the main routes of travel are fixed by international agreement; and in the North Atlantic Ocean where many ships pass, these routes serve especially as double tracks on a railway. All boats traveling from European to American ports are required to keep between fixed degrees of latitude, and boats moving from American ports to Europe between other fixed degrees of latitude. These trade routes change with the seasons, for during the summer months great icebergs float down from Greenland and become a menace to navigation.



The periscope is the eye of the submarine. Explain.

Government aids in navigation. — To reduce to a minimum the loss of life and valuable property in ships and cargoes, governments protect boats from possible dangers and have routes carefully charted and marked with buoys. Some buoys are equipped with whistles to warn of danger; some mark channels and are often provided with lights at night. There are great lighthouses which can



The Panama Canal saves 8000 miles in a water trip from the Atlantic to the Pacific coast.

be seen from thirty to forty miles away. Life-saving stations are located on dangerous parts of our coast and during a storm men constantly patrol the shore so as to render quick aid in case of a wreck.

Canals as waterways. — In early days before the railroads, rivers were of great importance as a means of transportation. Then came a period roughly from 1820 to 1840 when canals were built in great numbers, comprising altogether 4468 miles. Most of these canals, however, were destined to failure when the railroads entered com-

petition with them. The Erie Canal with its 363 miles of waterway, the Chesapeake and Ohio Canal, and a few others are still in existence. Of great importance is the recent Barge Canal in New York state which was completed in 1918 and has a capacity for boats several times the size of those on the old Erie Canal. Our modern



New York barge canal.¹

achievement in digging the Panama Canal is one which we can well afford to be proud of as a nation. One of the most notable undertakings of modern engineering is that of the Marseilles-Rhone Canal in France, where not only has the canal followed the Rhone, but part of its route actually cuts through a range of mountains with a tunnel about 5 miles long and 77.5 feet wide by 47.5 feet high.

Inland waterways. — The development of North America has been greatly influenced by its splendid inland waterways. Not only have we several great river systems

navigable for thousands of miles, but the chain of the Great Lakes forms a cheap and easy means of transport for ore and grain. In addition, Canada and the United States have built great canals with locks at the "Soo" and between Lake Erie and Ontario, and the United States has dredged a wide ship channel through the shallow waters of Lake St. Clair. The yearly tonnage through the "Soo" locks is greater than that in any other canal in the world.

REFERENCE BOOKS

- Adams, *Romance of Submarine Engineering*. J. B. Lippincott Company.
 Baldwin and Livengood, *Sailing the Seas*. American Book Company.
 Bishop, *Story of the Submarine*. The Century Company.
 Bishop and Keller, *Industry and Trade*. Ginn and Company.
 Bond, *Pick, Shovel, and Pluck*. Munn and Company.
 Collins, *The Boys' Book of Submarines*. F. A. Stokes Company.
 Cressey, *Discoveries and Inventions of the Twentieth Century*. E. P. Dutton.
 Darling, *All About Ships*. Funk and Wagnalls.
 Domville-Fife, *Submarine Engineering of Today*. J. B. Lippincott Company.
 Hall, *Modern Weapons of the War, By Air, Sea and Land*. Blakie.
 Hall, *Wonders of Transport*. Dodge Publishing Company.
 Hepburn, *Artificial Waterways of the World*. The Macmillan Company.
 Howden, *Boys' Book of Steamships*. McClure Company.
 Hughes, *Community Civics*. Allyn and Bacon.
 Johnson, *Elements of Transportation*. D. Appleton and Company.
 Johnson, *Panama Canal and Commerce*. D. Appleton and Company.
 Johnson, *Modern Inventions*. F. A. Stokes Company.
 Kennedy, *Newark Study*. (For teachers.) Board of Education, Newark, N. J.
 Maule, *Book of New Inventions*. Grosset and Dunlap.
 Moffett, *Careers of Danger and Daring*. The Century Company.
 Smith, *The Ocean Carrier*. G. P. Putnam's Sons.
 Smith and Jewett, *Introduction to the Study of Science*. The Macmillan Company.
 Talbot, *Lightships and Lighthouses*. J. B. Lippincott Company.
 Talbot, *Submarines: Their Mechanism and Operation*. J. B. Lippincott Company.
 Tappan, *Children's Hour*. Vols. 14, 15. Houghton Mifflin Company.
 Trafton, *Science of Home and Community*. The Macmillan Company.

CHAPTER XXVIII

TRANSPORTATION THROUGH AIR

Problems. — 1. *To learn of the development of aërial flight.*

2. *To understand the principles underlying balloon ascension.*

3. *To learn the advantages of airships over balloons.*

4. *To understand the principle by which heavier-than-air machines can remain in the air.*

5. *To learn something of the stability and method of control of airplanes.*

Suggested project. — 47. To make an aircraft scrapbook.

Through the air. — To fly as on the wings of a bird has become an actuality at last. While air transportation was slowly coming into its own, the World War suddenly threw it into prominence, and as successful warfare depended largely on a knowledge of the movements of the enemy, the airplanes, dirigibles, and balloons became the eyes of the army, and went a long way toward winning the war for the allies. Man has produced machines in which he can fly as well as birds, and can perform trick movements also which even birds do not attempt. There are two classes of machines now in use in the service, known as lighter-than-air machines and heavier-than-air machines. Their names indicate exactly what they are.

First lighter-than-air machines. — The French were the pioneers in developing balloons. The earliest ones were made by the Montgolfier brothers in 1783, and were called fire balloons, because a straw fire was built under the gas bag to supply hot air which caused them to



One of Montgolfier brothers' fire balloons.

rise. In that same year, hydrogen, which, as you know, is a gas many times lighter than air, was used. During the next fifty years numerous ascents were made by adventurous spirits which gave much additional information about the envelope of air surrounding the earth. Some daring balloonists reached an altitude of seven miles above the earth, and although they nearly lost their lives in these hazardous flights

they found that there is only one-fourth as much air at that height as there is at sea level. Since then, it has been possible to estimate pretty clearly that if this ratio were kept up, there would be little if any air one hundred miles above the surface of the earth.

Demonstration Experiment. — To discover what common gases are lighter than air.

Materials: Collect two test tubes each of carbon dioxide, oxygen, hydrogen, and illuminating gas.

Method of Collecting Gases: 1. *Carbon dioxide.* Put marble or washing soda in the generator; add dilute hydrochloric acid. Close and collect gas by water displacement.

2. *Oxygen*. Drop a small lump of oxone into water in the generator.
3. *Hydrogen*. Put zinc into dilute sulphuric acid in generator.
4. *Illuminating gas*. Connect rubber tube to gas cock and collect as in other cases over water.

Method: Hold one tube of each gas mouth down for 3 minutes and apply test for the presence of the gas. Hold another tube of each gas mouth up for 3 minutes and apply test for the presence of the gas. Test with lighted taper. Flame is extinguished in carbon dioxide. It burns brighter in oxygen. Hydrogen explodes sharply. Illuminating gas gives slight explosion or burns.

Results: Which gases are found to be lighter than air?

Application: Name some practical use of a gas depending upon its lightness.

Why balloons rise and float. — A balloon rises because it is pushed up by the air which is denser than the gas in the balloon. Hence only those gases which are lighter than air can be used. The higher the atmosphere, the less is its lifting power, because its density decreases as it ascends. When a balloon has risen until its total weight equals that of the air it displaces, it ceases to rise, and becomes a floating body, very much like a boat.

Buoyancy of air holds up objects in the sea of air just as water holds up objects which weigh less than the amount of water displaced. One thousand cubic feet of air weigh eighty pounds, and one thousand cubic feet of hydrogen weigh only five and one-half pounds. A balloon carrying 200,000 cubic feet of hydrogen has then a lifting power of $74\frac{1}{2}$ times 200 or 14,900 pounds. Part of this lifting power is used to hold up the material of the bag and balloon car, and the rest is used for ballast and passengers.

Experiment. — To study the action of soap bubble balloons.

Uses of balloons. — Balloons, as we have seen already, are not of much value for transportation, as one has to

depend entirely upon the wind currents. A skilled balloonist is able by shifting the altitude of his balloon to take advantage of winds moving in different directions. The captive balloons at the front lines of the armies in the



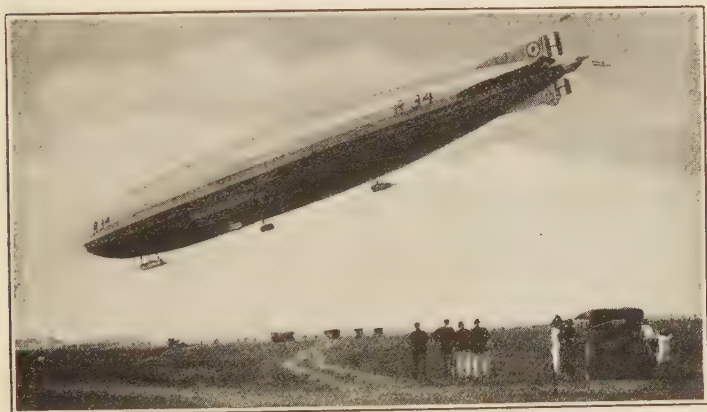
An army observation balloon.

World War proved of very great value indeed, as they were able to direct the fire of artillery, to prevent surprise movements of troops, and to give signals in case of attack of hostile airplanes.

The dirigible. — For a great many years people worked on plans to steer balloons. In 1850 a Frenchman by the name of Giffard built a cigar-shaped gas bag under which he placed a car containing a steam engine. This was not very successful, and later

gasoline engines were used. Captain Renard of the French army in 1885 was the first man to bring his cigar-shaped balloon back to its starting point. Santos Dumont in 1901 won a \$20,000 prize for steering his dirigible around Eiffel Tower and coming back to his starting point, a distance of three or four miles. It is interesting to remember that he used an automobile engine, so that the automobile helped in

the development of the dirigible. The first part of the war brought into prominence the rigid dirigibles of Count Zeppelin of Germany. These great machines were made of a large number of sections, each one of which was a distinct balloon by itself, and the entire lifting body of the balloon was made rigid by means of aluminum bars and rings. The dirigible did not do as much damage as

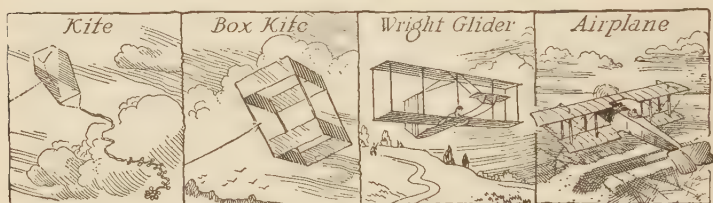


The English dirigible which made the first round trip across the Atlantic, landing on Long Island, N. Y.

was expected during the World War, but now, in times of peace, the commercial possibilities of airships seem to be very great. The English dirigible, R 34, in July, 1919, made the first round trip between Europe and America, the return, with favoring winds, taking only a little over seventy-two hours.

Forerunners of the airplane. — Every boy knows how to fly a kite. He also knows that the stronger the wind, the better his kite will fly. When the wind blows against the surface at right angles it exerts a pressure which tends

to push the surface in the direction of the wind. When the wind blows against the surface at some other angle, it tends to move the body at an angle to the direction of the wind. This is due to the fact that the wind upon striking the kite is deflected, but reacts to push the kite in a direction which depends upon the angle between the kite and the direction of the wind. It is only a step from

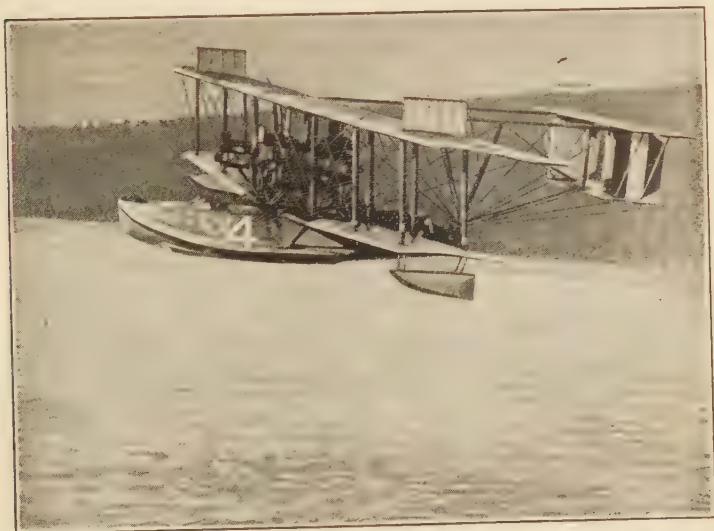


the box kite to the glider, which is a huge box kite arranged to hold a person.

Experiment. — To show the principle of the glider.

The invention of the airplane. — Like so many other great inventions, the airplane is not the work of any one man. Americans have had a prominent place among those who worked on its development. Professor Langley succeeded in making a model airplane run by a small steam engine fly out over the Potomac for 900 yards at the rate of about 25 miles an hour. The Wright brothers experimented with gliders, and learned much about the laws of flight. In 1903 they placed a gasoline engine on their glider, and made exhibition flights of a whole minute in duration. The rapidity with which improvements have been made may be realized when we recall the successful trip by airplane of Sir Ross Smith, in 1920 from England to Australia, or half around the world.

The first transatlantic flight. — The N-C 4 (Navy-Curtiss No. 4) has the distinction of being the first airplane to cross the Atlantic. On May 31, 1919, it completed this flight of 4513 miles, having made five stops on its way. The longest flight on the trip was 1380 miles from Newfoundland to the Azores. The airplane with its load



The American airplane, the N-C 4, was the first to cross the Atlantic.

weighed 14 tons and was commanded by Lieutenant Commander Albert Cushing Reed of the United States Navy. The trip was begun at Rockaway, Long Island, and ended at Plymouth, England. The first non-stop flight was made June 14, 1919, from Newfoundland to Ireland, a distance of 1890 miles, by the Vickers-Vimy airplane piloted by Captain John Alcock of the British Army, and navigated by Lieutenant Arthur W. Brown, an American in the British service.

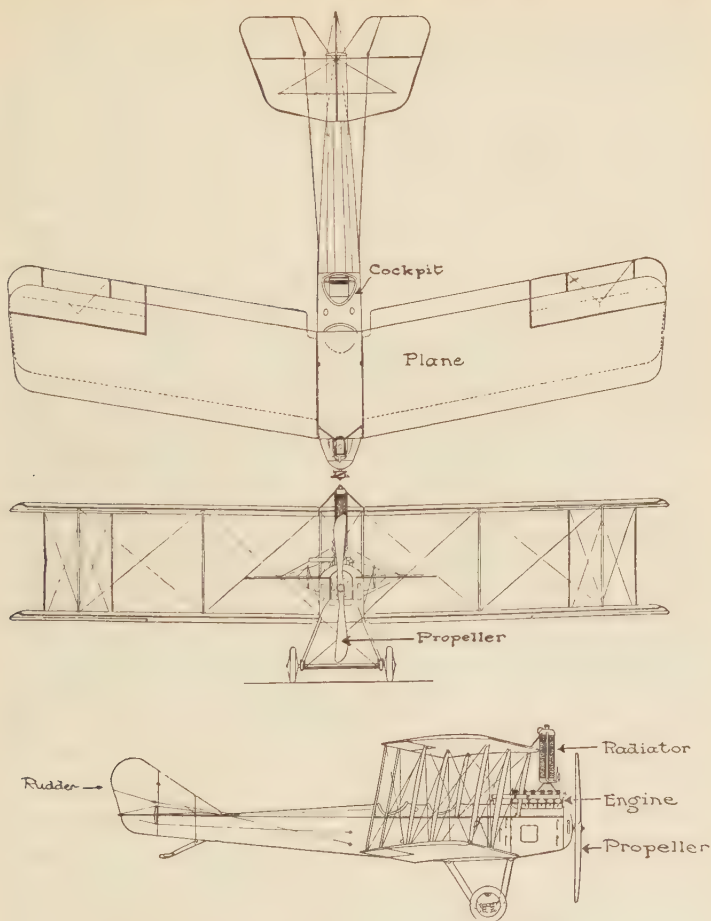
Types of airplanes. — In the growth of the airplane we have had two types of machines: the monoplane, in which a single set of planes is used, and the biplane, with two sets of planes. The latter has come into almost universal favor. The fuselage, or body of the plane, contains the motor, room for pilot, operator and storage for such instruments or implements as are necessary. At the rear the fuselage tapers into a tail, to which are attached the rudders, elevators, etc. The propellers may be placed in front, in which case we call the plane a tractor, or if the



The Vickers-Vimy airplane made the first non-stop flight across the Atlantic.

propellers are in the rear it is called a pusher. Numerous models have been developed on these two lines. The hydroplane is an airplane fitted with floats on which it rests on the water. It rises from and alights on the water.

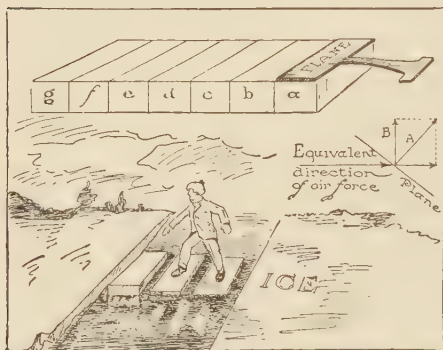
What supports the airplane. — The so-called “planes” of the airplanes are really arched or convex as viewed from the top. In ordinary flight these planes are tilted about eight degrees from horizontal, and as the propeller pushes back the air the planes are pushed forward. Because of this motion air strikes against the concave side of the plane with considerable force. One result of this is the lifting effect which counterbalances the force of gravity, which is always pulling downward on the machine.



Showing general features of the tractor airplane.

The support of the airplane is somewhat similar to that of a man who crosses the river on floating logs or on loose blocks of ice. One block of ice, of the size usually cut in ice harvesting, would sink if the man were to stand

on it, but he may step on it, and before it has time to sink, step to another block, and then to another. In this way he can travel any distance on blocks of ice which individually are too small to support his weight. He makes use of the "inertia of rest." It takes time to set the block



Why the airplane does not fall (see text). A more scientific explanation involves resolution of forces as suggested by diagram at right. *A* at right angles to the plane is one component of the air force acting upon the plane. *B* is that component of *A* which lifts the plane.

of ice in motion and before it sinks he has passed on to another block.

Can you think of the air as being composed of blocks of air? The airplane rests on one block of air for an instant, but before that air can sink, it passes on to the next block, and so on. The

airplane must travel

faster in the air than the man on ice blocks, because the air can be moved faster than ice, and because the airplane is heavier than the man.

Lifting force, speed, and power.—The air support depends upon the area of the plane. Double the plane area will give double the supporting force. The air support also depends upon the speed; double the speed will give four times the lifting force. It is thus seen that the lifting power of an airplane increases directly with the surface area of the plane and directly with the square of the speed. In order to double the speed of an airplane the power must be increased eight times.

How to rise and fall. — By driving at a high speed, the planes being slightly inclined, the air exerts an upward pressure sufficient to lift the airplane to a higher level. At a slower speed the airplane will fall. For ordinary flight, however, special “elevator” planes are used for rising and for falling. These planes may be tilted at will, causing an upward or downward movement.



Air travel. Passengers getting aboard.

The “elevator” planes may be placed in front, at the sides, or in the rear.

Stability of airplanes. — Boats in the water are often subjected to disturbances, such as rocking from side to side and pitching bow and stern. Airplanes experience this same trouble, but in a greater degree. The water tends to keep a boat on even keel to a greater extent than the air can hold an airplane. Gravity is pulling the machine down, the pressure of the air is pushing it up. The pilot's seat is directly over the center of gravity of the airplane.

If the center of upward pressure is not at the same place as the center of gravity, a turning will result. The greater the distance between these two centers, the greater will be the tendency to upset. When one is rising or falling or when the speed is being changed, the center of pressure changes. The pilot can change the center of pressure by use of the elevator planes and he tries to keep it in the same position as the center of gravity. There are automatic devices, which assist him, but none as yet can replace the alertness of the pilot, who must acquire the habit of instinctively doing the right thing at the right time.

Present and future. — The airplane is a prime necessity of modern warfare. Scout planes are built which can travel two hundred miles per hour. Regular airplane service is now established for mail delivery between distant cities in the United States. Passenger planes carry fifty passengers. The airplane can travel for hours without a stop and can fly in any wind except a gale. Transportation in air may never compete to any great extent with land and water transportation, but its usefulness has been already established. Boat traffic is often seriously interrupted between the mainland and islands off the coast in the winter. Ice packs are no hindrances to air service. We may confidently expect the establishment of an air line between America and Europe, and between Europe and Asia, since the feats of American and British fliers have proved such service entirely feasible.

Scientific study of conditions in the upper air has been made possible by the balloon and airplane, the balloon with passengers having reached an altitude of 30,000 feet, while on September 28, 1921, Lieutenant Macready of

the United States Army ascended in an airplane to a height of 34,509 feet at Dayton, Ohio.

The development of the airship has been hindered by numerous disasters, the most recent having occurred in our own dirigible, the *Roma*. If a quantity of helium, a non-explosive gas, can be obtained at a reasonable cost to replace the inflammable hydrogen now used, there is no reason why the airship may not become an important agent for passenger and freight service.

REFERENCE BOOKS

- Aëro chart; Navigating the Air.* Doubleday, Page and Company.
Abbott, *Aircraft and Submarines.* G. P. Putnam's Sons.
Bachman, *Great Inventors and their Inventions.* American Book Company.
Burns, *The Story of Great Inventions.* Harper and Brothers.
Collins, *How to Fly.* D. Appleton and Company.
Collins, *The Boys' Book of Model Aëroplanes.* The Century Company.
Collins, *The Air Man, His Conquests in Peace and War.* The Century Company.
Cressey, *Discoveries and Inventions of the Twentieth Century.* E. P. Dutton Company.
Darrow, *The Boy's Own Book of Great Inventions.* The Macmillan Company.
Dillacombe, *Boy's Book of Airships.* (Interesting because of story of early development.) F. A. Stokes Company.
Johnson, *Flying and Some of Its Mysteries.* Hodder and Stoughton.
Johnson, *Modern Inventions.* F. A. Stokes Company.
Maule, *Boys' Book of New Inventions.* Grosset and Dunlap.
Moffett, *Careers of Danger and Daring.* The Century Company.
Rolt-Wheeler, *The Wonders of War in the Air.* Lothrop, Lee and Shepard Company.
Smith and Jewett, *Introduction to the Study of Science.* The Macmillan Company.
Towle, *Heroes and Martyrs of Invention.* Lothrop, Lee and Shepard Company.
Trafton, *Science of Home and Community.* The Macmillan Company.

CHAPTER XXIX

MEANS OF COMMUNICATION

Problems. — 1. *To see how means of communication have developed.*

2. *To understand different methods of signaling.*

3. *To appreciate the value of mail service.*

4. *To understand how communication is possible by telegraph.*

5. *To understand the working of the telephone.*

6. *To realize what an important part newspapers and other printed matter play in the world to-day.*

Suggested project. — 48. To become a radio expert.

Early communication by means of signals. — Signs and signals have been in use perhaps as long as words,



Torch signals used by the Greeks.

and they find as important a place in the world to-day as they did in that of our ancestors. From earliest recorded time people have had means of signaling, the simplest being the flaming torch or bonfire by night. The Romans

maintained fires on the coast headlands to guide their triremes of war and commerce. The Greeks developed an elaborate method of torch signal communication so

that by using a screen to hide the torches not in use, they could signal all the letters of the Greek alphabet (see page 462). The American Indians sent daylight messages by covering a fire for a short time with a blanket and quickly uncovering it, and thus sending up rings of smoke which could be seen 20 miles away. The Eskimo finds it more difficult to use fire and does his signaling with his arms. He stands, when possible, on a hill against the sky facing his observer. By moving his arms up and down at the sides he gives his message. Eskimo wig-wagging seems to have been the forerunner of semaphore signaling, now in so common use by railroads, and by the army and the navy in directing maneuvering.

The use of light in signaling. — Beacon Hill in Boston derived its name from the fact that a beacon light on it warned the colonists of the approach of hostile Indians. Lantern light gave Paul Revere the information that started him on his famous midnight ride. What boy or girl does not know the use of a small mirror in throwing a beam of sunlight? The heliograph is an instrument which flashes messages in the sunlight. The distance is usually



Sending a message by heliograph.

limited to 100 miles, but in exceptional cases it has been increased to nearly 200 miles. This is an important instrument in the national forests, where it is used for communication from one station to another.

Ear signals. — In communicating by signals we may use two of our senses: hearing as well as seeing. Signaling by sound requires a medium, usually the air, to conduct the waves from their source to the ear. You may remember that sounds are vibrations of matter within such limits of frequency (sixteen to forty thousand a second) as will affect the organ of hearing.

Ear signals are perhaps less important than eye signals, and yet they serve many conditions where eye signals would fail. The door bell, telephone bell, church and school bells, the fog horn, automobile horn, fire alarm and the factory whistle all give their message to the ear. But all methods of distance communication devised in thousands of years by man, are clumsy and inefficient indeed when compared with the telegraph, cable, telephone, and wireless, all of which have been developed within the memory of your parents or grandparents.

Mail service. — An invaluable service to commerce, business, and the household is performed by the mail delivery. Even the distant rural population receives and sends written messages at small cost and at frequent intervals of time. United States mail carriers have the right of way over all other traffic, except in emergencies such as fire or hospital services. To increase the speed of delivery, air service has been already established between some large cities, and in the future this will undoubtedly form an important part of the post office department.

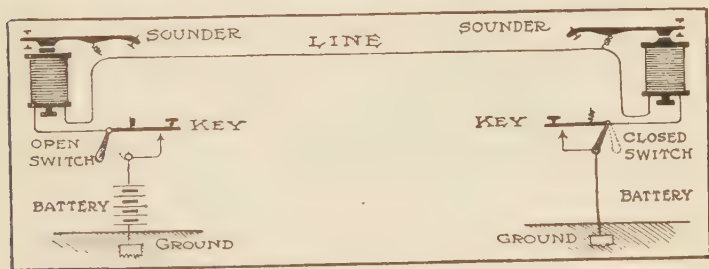
How letters are delivered to their destination. — After mail is collected from the letter box it is taken to the post office, where it is roughly sorted and put on a mail car going north, east, south, or west. On this car are postal clerks whose business it is to sort out the letters going to certain cities or areas of distribution. Before the mail train reaches the destination of your letter, it has been placed in a bag with all the other first-class mail for that locality and is ready to be put off at the proper station. From the station it is taken to the post office where it is put into its proper box or sent out by the city carrier or the rural free delivery carrier to be delivered finally to the person to whom it is addressed.



Interior of a mail car.

The telegraph. — As early as 1831, Joseph Henry produced sounds at a distance by means of electromagnets. The system devised by Samuel F. B. Morse in 1832 and perfected in 1843 is the one, however, which has been generally used, and is known to-day as the electric telegraph. Much experimental work and many improvements were made before the telegraph became commer-

wire, a battery, two keys, and two sounders. The double-wire line well insulated is best, but a one-wire line may be used if connected to a water pipe which, with the ground, makes a return circuit to replace the second wire. The battery should consist of two or more gravity cells joined in series. The key is a device for opening and closing the circuit. The interruption in the flow of the current produces a signal in the sounder at the other end of the line. When no message is being sent, the switch attached to the key is closed. The current always flows through the



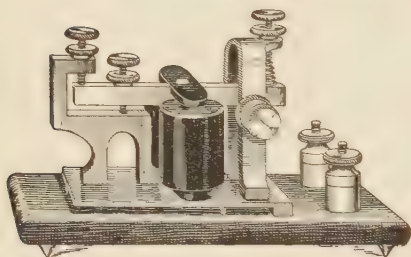
A complete telegraph system. Shown ready for the operator at the station at the left to send a message.

entire circuit except for the interruption during the sending of the message.

Experiment. — To see how the electric telegraph works.

How the message is received. — The essential parts of a sounder are an electromagnet and an armature. When at rest, the armature is held close to the electromagnet. If the switch is open, the current stops. There is no longer any magnetism to hold the armature and it is raised by a spring. Upon pressing the key the current flows, magnetism is produced, the armature is drawn down, and the blow on the yoke results in a loud click. The interval of time between successive clicks is determined

by the length of time the key is kept closed. A short interval makes a "dot," and a long interval makes a "dash." Dots and dashes in different combinations



Telegraph key and sounder. Name the essential parts shown.

stand for the letters of the alphabet. Below will be seen the Morse Telegraph Code.

In commercial lines where messages are sent long distances, another instrument, the relay, is used. This is more sensitive than the sounder, and will operate on a current which is too weak to operate the sounder.

The Atlantic cable.—

In 1857 a submarine cable was laid from Newfoundland to Ireland, but after working for 18 days it went out of commission and it was not until after the close of the Civil

A.—
B—...
C.. .
D—..
E..
F—..
G—..

H....
I..
J—..
K—..
L—..
M—..
N—..

O..
P....
Q....
R..
S..
T—

U...
V...
W—..
X—..
Y—..
Z... .

War that Cyrus W. Field finally succeeded in laying another cable. Since that time cables have been simplified so that they now connect almost all parts of the world.

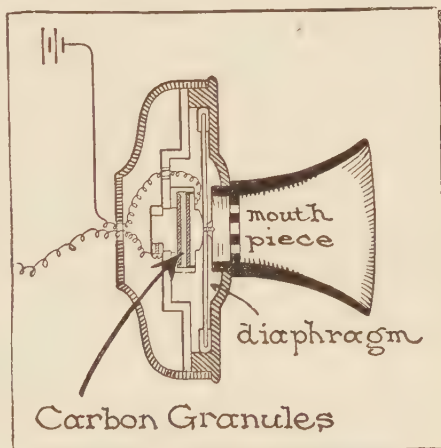
The telephone. — The telephone offers an example of the rapidity with which useful scientific inventions are

adopted in modern times. The telephone was invented about fifty years ago; it has been in commercial use about thirty years, and to-day there are over eleven million telephones in use requiring nearly 30,000,000 miles of wire. People in San Francisco and New York converse with each other with as much ease as if they were sitting in adjoining chairs, and by wireless telephone conversation is carried on between an airplane high in the air and the ground, or between Europe and America.

Experiment. — To study the action of the telephone transmitter.

How the telephone transmits sound. — The ordinary telephone system is very complicated, and yet it

is not difficult to understand the simple physical principles underlying its use. We must first of all recall what causes sound, how the voice is produced, and picture the sound waves as vibrations of the air traveling to the transmitter. There, contrary to popular belief, the sound waves stop. No *sound waves* pass over the telephone wire. The transmitter is a little box filled with carbon granules which form a part of an electric circuit, but offer a rather high resistance to the flow of current. If the carbon particles are pressed closer together, resistance is decreased and more



Telephone transmitter.

current flows. When they separate, less current flows through them. If we were to compress and release the walls of the box alternately, a variable current increasing with pressure and decreasing with absence of pressure would pass through the circuit. One wall of this carbon box is attached to a thin diaphragm just inside the mouthpiece of the transmitter. Sound waves are vibrations, the air becoming first more and then less dense in rapid succession. Each compression pushes the diaphragm forward and presses the carbon particles closer together. As the air becomes less dense the diaphragm springs back



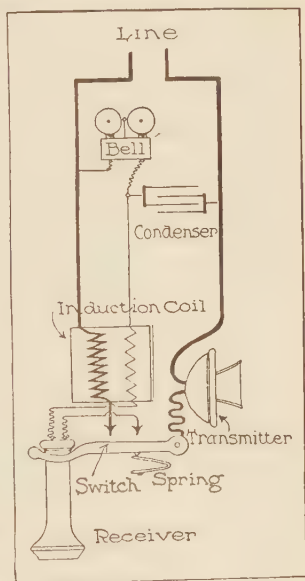
Telephone receiver.

to its natural position and the carbon particles separate. In this way, a pulsating current is made to pass through the wire. The number of pulsations and their intensity correspond to the number of vibrations and the intensity of the sound produced in the mouthpiece of the transmitter.

Experiment. — To study the action of a telephone receiver.

How the receiver gives us the sound waves. — Suppose the electric circuit in which the transmitter is connected also includes a telephone receiver at a distance. What will happen when the pulsating current comes to it? If you should unscrew the cap at the end of the receiver you would find a thin soft iron diaphragm held in place by a permanent magnet. Remove the diaphragm and you will find a small coil of wire around the end of the magnet. This coil forms the part of the electric circuit which carries the pulsating electric current. Every time

the current is increased the magnetism is made stronger and the diaphragm is drawn closer to it. Every time the current decreases the magnetism becomes weaker and the diaphragm springs back. This completes the vibration. Vibrations are made as often as the pulsations of the electric current occur and these, you recall, correspond to the number of vibrations of the voice in the transmitter mouthpiece. The vibrating diaphragm of the receiver sets up sound waves in the air which are duplicates of those given to the transmitter. Thus it is that speech is reproduced at the other end of a telephone line with no sound waves, but only pulsations of electric current being transmitted over the wires. In order to strengthen the loudness and decrease the loss of electricity along the line, an induction coil is used in the telephone instrument to "step up" the voltage.

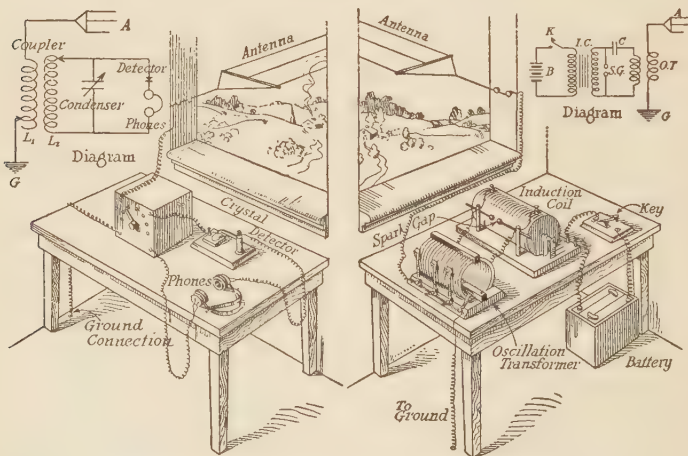


Instruments in a subscriber's telephone set.

Early beginning of wireless. — Joseph Henry discovered in 1842 that whenever an electric spark was produced an oscillatory electrical wave was sent out into space in all directions. Such electromagnetic waves were first detected by Hertz in 1888 when he observed that while producing electric sparks with an induction coil, various nearby metallic bodies displayed electrical vibration. A young Italian, Marconi, heard of these experiments and

thought that signals such as Morse had used in the telegraph might be sent by these waves and thus make some practical use of their discovery to mankind. It was a long and a difficult task to find out the necessary conditions for sending waves and receiving them, but by persistent effort success was finally achieved.

Sending a message. — In the sending of radio or wireless messages electrical disturbances are produced in a



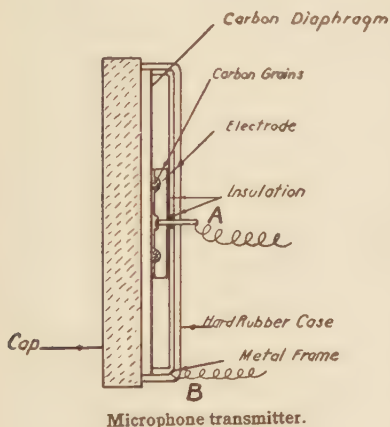
Apparatus for sending and receiving wireless messages.

circuit joining the aërial and the ground so that from the aërial electromagnetic waves are sent out in all directions with the speed of light. In sending a radio telegram it is only necessary to set up intermittent electromagnetic waves such as result when sparks are discharged by means of an induction coil. The sending of speech is more difficult. In the radio telephone waves of high frequency are sent continuously through a microphone transmitter whose resistance is changed by sound waves such as are pro-

duced by music and by the voice. The changes in resistance modify the amplitude or intensity of the waves. These modified waves reproduce in the telephone receiver at a distance, the same sound waves as those which

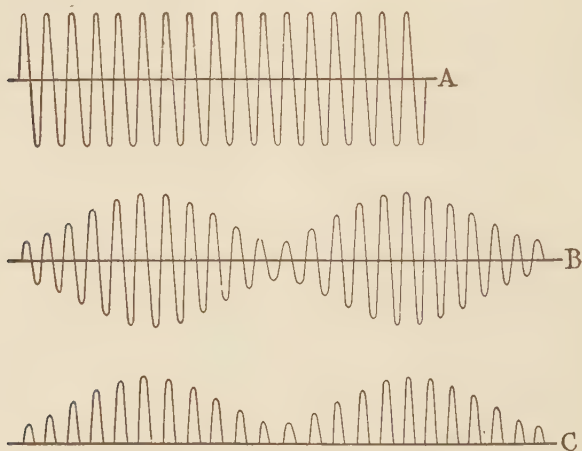
brought about the modification of the continuous transmitting waves at the sending station.

Receiving the message.—Each wave caused by the spark discharge when received produces a sound wave in the receiving instrument. A short spark, a long spark, and the intervals between two successive sparks are readily recog-



nized, so that by means of a code communications can be carried on. When the modified waves of the radio telephone are caught by the receiving antenna they are carried to a transformer where they are intensified. They then go to a detector where they are rectified, that is, changed from an alternate to a direct current. These rectified waves still retain the variation in amplitude, so that as they go to the telephone receiver they carry stronger and weaker electric waves which are timed in their action to correspond to the number of vibrations of the sounding body which caused the varying intensity in the radio waves. As a result the diaphragm of the telephone receiver is set into vibration to correspond to this pulsating current and thus reproduces the sound waves made at the sending station.

Modern radio detectors. — Present day detectors depend upon the use of substances which permit electricity to flow in one direction only. When an oscillating wave reaches the detector only one part of that wave is allowed to pass and the rectified current is used to reproduce sound in the telephone receiver. There are two important types of detectors, namely, the crystal and the vacuum.



A. Continuous wave. B. Modified waves. C. Rectified waves.

The crystal detector, which is of value for relatively short distances, consists of a crystal, such as galena, in loose contact with the end of a very fine adjustable phosphorus bronze wire. This is placed in parallel with the other receiving instruments in the circuit between the antenna and the ground. The vacuum tube detector is a far more sensitive instrument, with which it is possible to hear over greater distances. For short distances the crystal is superior often to the vacuum tube, since the latter produces

noises which when amplified may interfere with the reception of music and speech.

Wave lengths. — By suitable devices and adjustments at the sending station the length of the electromagnetic waves may be controlled with a fair degree of accuracy and they may be sent out 200 meters to 30,000 meters

in length. Each amateur receiving set can cover a part of this range and by proper devices the entire range may be included. "Tuning" consists in changing the "electrical length" of the aerial by means of connecting coils, so that it will pick up the waves of a certain length and exclude others. In

A.—	N--	1-----	· · · · ·
B----	O---	2-----	, -----
C----	P----	3-----	? -----
D---	Q----	4-----	- -----
E ·	R--	5-----	() -----
F ----	S---	6-----	" " -----
G---	T-	7-----	! -----
H----	U---	8-----	' -----
I ..	V----	9-----	; -----
J----	W--	0-----	: -----
K--	X----	Continental Code.	
L----	Y----		
M--	Z----		

this way the interference of two or more messages of different wave lengths may be prevented. In order to prevent the

interference with important messages, the government tries to control the situation by the designation of certain wave-lengths for specific classes of radio, and by international agreement, certain lengths are agreed upon for service between different countries. The following classification is authorized: 200 meters for amateurs, 360 meters for ordinary broadcasting stations, 400 meters

for class B broadcasting stations or those which have superior equipment, 600 to 900 meters for ship to shore service and commercial stations, 1000 meters for radio beacons, 20,000 meters for commercial trans-oceanic stations, and a variety of wave lengths for different branches of government service.



A well-equipped wireless station.

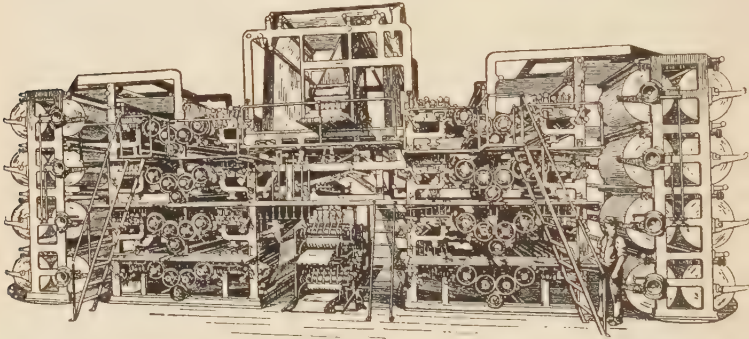
The importance of radio. — Radio instruments are coming rapidly to take an important place in our home life, as well as in that of the community. Every boy with scientific instincts has a radio set today and derives much profit as well as pleasure from its use. Radio broadcasting by central stations puts news, entertainments, weather and commercial reports in all homes having such

instruments. Commercially the radiophone is already in use and makes communication between moving trains, boats or airplanes possible. Trans-oceanic radio furnishes cheaper and more satisfactory service than the ocean cables. And best of all, radio has made it possible for ships in distress to communicate with others. Radio "beacons" or warnings may some day take the place of lighthouses, and radio time signals may be sent around the world. The coming generation may see and do things with the wireless of which we do not dream now, for we are just beginning to learn of its wonders.

The newspaper. — Perhaps no medium of communication exerts a wider influence upon our thoughts and actions than the newspapers and periodicals. It is a far cry from the crude press of Gutenberg, which would print half a dozen single sheets an hour, to the modern Hoe press which turns out our newspapers with almost lightning rapidity. The gathering of news, the editing, the typesetting, the plate making, the printing and delivering of the paper so that it can be bought with a printed account of important happenings within a few hours after they occur make up one of the marvels of modern achievements. It is said that half an hour after the death of Queen Victoria newspapers which told of it were being sold on the streets of New York.

Sending pictures and writing by wire. — Several successful devices have been invented by which pictures can be sent over telegraph lines. These processes are too complicated for description here. The telewriter is a modern instrument by which a person can write a message and have it rewritten instantly in his own handwriting hundreds of miles away. Telegrams and drawings are as

easily reproduced as writing. The telewriter depends in its action upon a properly adjusted system of resistances and electromagnets. The copy made by the receiving instrument is done with a pen which goes through the actual



Our newspapers are printed by means of very complicated machines.

operations of a similar pen in the hand of the sender. One cannot read of all these marvels without thinking of the first message sent over the telegraph by Morse: "What hath God wrought!"

REFERENCE BOOKS

- Adams, *Harper's Electricity Book for Boys*. Harper and Brothers.
 Baker, *Boys' Book of Inventions*. Doubleday, Page and Company.
 Carson, *History of the Telephone*. A. C. McClure Company.
 Collins, *Book of Electricity*, D. Appleton and Company.
 Collins, *The Book of Wireless*. D. Appleton and Company.
 Cressey, *Discoveries and Inventions of the Twentieth Century*. E. P. Dutton Company.
 Darrow, *The Boy's Own Book of Great Inventions*. The Macmillan Company.
 Doubleday, *Stories of Inventions*. Doubleday, Page and Company.
 Holland, *Historic Inventions*. G. W. Jacobs and Company.
 Lescarbours, *Radio for Everybody*, Munn and Company.
 Meadowcroft, *A-B-C of Electricity*. Harper and Brothers.
 Massie and Underhill. *Wireless Telegraphy and Telephony*. D. Van Nostrand Company.

Maule, *Boys' Book of New Inventions*. Grosset and Dunlap.
 Morgan, *Boy Electrician*. Lothrop, Lee, and Shepard Company.
 Perry, *Four American Inventors*. American Book Company.
 Shafer, *Harper's Everyday Electricity*. Harper and Brothers.
 Towers, *Masters of Space*. Harper and Brothers.
 Weir, *The Young Telephone Inventor*. Wild and Company.
 Wright, *Stories of American Progress*. Charles Scribner's Sons.

SCORE CARD. TRANSPORTATION AND COMMUNICATION

	PERFECT SCORE	MY SCORE
STREETS AND ROADS Surface of type well adapted to location and kind of traffic (5) Roadway of ample width and lined with trees (5) Upkeep of repair and cleanliness (5) Bridges conveniently located and well kept (5)	20	
RAILWAY One or more railway lines in the community, with local and express trains (5) A freight depot in the town (5) House express collection and delivery (5)	15	
STREET CONVEYANCES Frequent street car or jitney service locally and to near-by towns (5) Cars or jitneys adequate for traffic without overcrowding (5) Cost of travel in proportion to distance (5) Satisfactory bus or taxi service (5)	20	
WATER TRANSPORTATION A good harbor for ocean traffic (5) Lake or river transportation for fifty or more miles (2½) Canal extensively used (2½)	10	
MAIL SERVICE AND NEWSPAPERS At least two collections and deliveries daily (5) Daily paper published in town (10); within 10 miles (2)	15	
TELEGRAPH, TELEPHONE, AND SIGNAL SERVICE Day Telegraph service (4) Night Telegraph service (4) Local and long distance telephone (5) Fire alarm box signal system (2½) Police signal service (2½) Radio broadcasting station within 15 miles (2)	20	
TOTAL	100	

PART XII. THE DEVELOPMENT AND PROGRESS OF LIVING THINGS

CHAPTER XXX

GARDENS AND THEIR PLACE IN THE COMMUNITY

Problems. — 1. *To understand the value of gardens in a community.*

2. *To understand the nature of soils.*

3. *To see in what respect animals and plants are alike.*

4. *To understand how the important plant foods are supplied.*

5. *To learn how a plant manufactures food.*

6. *To learn what forms of animal life are friends of our garden.*

7. *To know the life history of common insect pests.*

8. *To learn how to fight plant enemies.*

9. *To learn how to force early vegetables.*

Suggested project. — 49. *To see how plants are improved in every community.*

Gardens and their place in a community. — During the World War it became the fashion for people to cultivate "war gardens" as they were determined to save food for the allies and this was a method by which it could be produced cheaply at home. So vacant city lots were

cultivated by those who were willing to devote themselves to this work. War gardens in this country were estimated to have supplied in 1918 nearly five hundred million dollars' worth of vegetables, a sum equal to about one twelfth of the Fourth Liberty Loan. It was found early in 1917 that there were 186,000 vacant lots in New York City, and 5000 acres in Minneapolis, Minnesota, most of



A community garden.

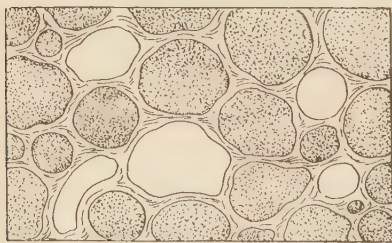
which space was available for war gardens. These figures could doubtless have been duplicated in cities in all parts of the country, and they indicate what a large amount of land is not used under ordinary conditions. It will be the purpose of this chapter to show how and why gardens are an asset to a community.

Green plants as food makers. — We have already learned that cereal crops are one of the sources of wealth to our country and that many communities owe their importance to the marketable foods grown in the vicinity.

But we are apt to forget that people all over the world owe their existence to green plants, the real food makers, which supply herbivorous animals as well as man with food. We do not always think of plants as living things which require food for themselves. We may think that water and mineral substances in the soil are their food but such is not the case. Plants use carbohydrates, oils, and proteins, the same foods as animals do. But they make these foodstuffs for themselves out of raw materials taken from the soil, the water and the air. We can understand better how this is done after a study of the soil and how it is prepared for gardening.

What is soil? — We have already learned that soil is composed largely of inorganic material, such as powdered rock, and that it usually contains organic material which comes from the decay of plants and animals. Dark soil is rich, because it has a great deal of organic material in it. Soils may be sandy or clayey, and thus we sometimes

speak of them as light or heavy; a heavy soil like clay holds water.



The soil particles are each surrounded by a film of water.

Experiment. — To test a sample of garden soil for acidity.

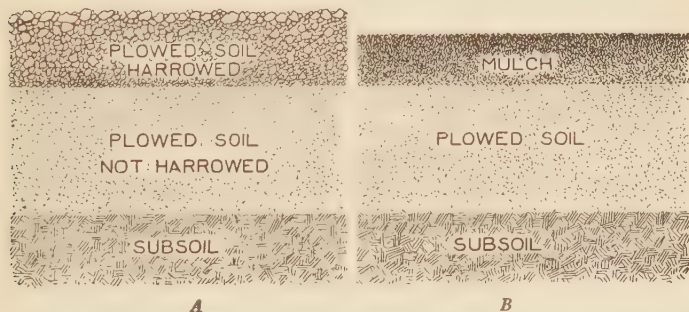
Water in the soil. —

You are all familiar with the fact that coffee creeps up on a lump of sugar placed partly in it, and that oil rises in a lamp wick. This rise of fluids against the force of gravity is called *capillarity*. Soil, if examined under a magnifying glass, is found to be made up of millions of particles of different

sizes, each particle holding around it a little film of water as shown in the diagram. Water rises through the spaces between the soil particles by capillary action, and thus it is found in the soil not far from the surface.

Experiment. — To show capillarity in gravel, sand, clay, and loam.

Air in soil. — This same loose, porous structure of the soil allows a certain amount of air to remain in the spaces. Plants breathe, because they need the oxygen of the air just as much as we do. And since the delicate roots of



A, Soil as left by the harrow. **B,** The same soil packed by rain. (After Mayne and Hatch.)

plants absorb air as well as water, porosity of soil is very necessary for the garden.

Experiment. — To show the effect of cultivation in preventing the loss of soil water.

Effects of cultivation on soil. — In order to keep the soil from being packed too firm and hard, and thus preventing water and air from passing through it readily, we cultivate, or break up the top layer of the soil either by hoeing, raking, harrowing, or by means of a cultivator. Cultivation crumbles the soil, and allows the plant roots to creep through it more easily. It breaks up the soil particles so

that water can dissolve out the materials which the plants use for food and allows air to pass through the soil. By either a loose mulch or a broken surface (see diagram page 483) water is more easily kept in the garden soil.

Mineral materials in the soil. — While soils differ a good deal in their mineral content, there are certain min-



Result of test to show need of mineral foods.

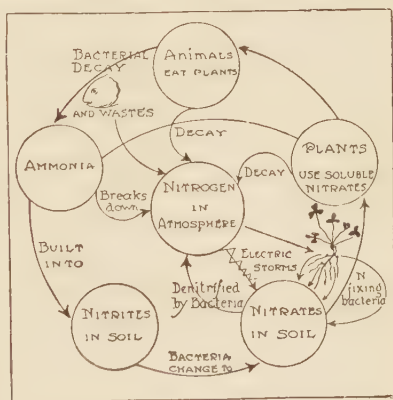
erals which must be present in small quantities in order that plants may grow. Living matter is a very complex substance. We cannot give the exact proportion of its elements, but we know that it contains large portions of carbon, hydrogen, oxygen, nitrogen, and very small portions of calcium, sulphur, potas-

sium, magnesium, phosphorus, sodium, and chlorine. It is easy to show by growing plants in water containing solutions of these different mineral materials, that the plants will not grow if certain of these ingredients are not found in the water which they absorb.

Plants and animals compared. — It is a matter of common knowledge that green plants are composed of roots, which usually penetrate the ground, a stem, which branches above ground, and green leaves, which are held up by the stem. We also find occasionally flowers and fruits forming a part of the plant. But it is not so evident, unless one uses a compound microscope, that both plants

and animals are composed of tiny units of structure called cells. These cells vary greatly in size and in use. We find them making a protective covering, growing into elongated tubes which carry fluids, forming the skeletons of plants and animals and growing into tissues, or collections of the same kind of cells, whereby they give characteristics to different kinds of plants and animals. In some respects however, cells are alike in both. They form the ultimate building material out of which all living things are made, and they are composed of the living material scientists call protoplasm. This protoplasm, although we do not know what gives it its quality of "aliveness," nevertheless can be resolved into the very chemical elements found in the soil and mentioned in the preceding paragraph.

We shall not try to show now how plants take in water. It is sufficient to know that water with its soluble mineral salts is absorbed by tiny root hairs and passed up through the roots and stems to the leaves where it is used in making living matter and food for the plant.



The nitrogen cycle. Follow the arrows and find out what becomes of the nitrogen.

Plants take nitrogen from the soil. — One necessary element in the composition of protoplasm is nitrogen. Nitrogen makes up nearly four fifths of the air and yet it is not in a condition which is available for use by plants

until certain bacteria in the soil have acted on it. Garden soil must be thought of as a place where millions of bacteria as well as other plants and animals live, some friendly and some unfriendly to the plants which are desired in the garden. If we examine soil for the presence of bacteria, we find many more in rich soil than in sandy soil, and



Nodules on roots of soy beans.

very many more near the surface than a little distance deeper in the ground.

Bacteria in the soil break down organic material, such as dead bodies of plants and animals, and help to oxidize it. Some nitrifying bacteria act upon ammonia (a product formed in decay) and change it to *nitrites*, while others change these nitrites to *nitrates*, which can be used by plants. Some of these bacteria live in little

nodules or lumps on the roots of clovers, peas, beans, and other plants called *legumes* and have the power in some mysterious way to take nitrogen out of the air and fix it so that it becomes usable in the soil as plant food. The changes through which nitrogen passes are too complex for us to explain at present, but we should remember that it is in circulation in all the world from the bodies of living

plants and animals, to the soil, there to be changed into soluble nitrates which may be absorbed by the roots and used by the plants again.

Reasons for rotation of crops. — It is common knowledge among boys and girls who have gardens that the soil “wears out” after a while, and that it becomes necessary either to add manure, which contains nitrogen in a usable form, or some artificial fertilizer which contains nitrates, phosphates, and potash. By raising peas, alfalfa, or clover, we can bring back the soil often to its former state of fertility. A boy who wishes to get the most out of his garden will rotate the crops, or make a combination planting. This will enable him to get much more out of his garden than if he planted only one crop. A good combination for two crops in a year would be early peas followed by tomatoes, squash, or sweet corn; or radishes, lettuce, or spinach followed by lima beans, string beans, or carrots; or string beans followed by celery, cabbage set out from plants, beets, or turnips. In which of each of these plantings do we get nitrogen provided for the soil?

Demonstration Experiment. — To test the starch making power of a plant.

Materials: A green plant. Black alpaca cloth. Wood alcohol. Iodine.

Method: Place any small green plant in a dark room for 24 hours. Then cover parts of several different leaves with strips of black cloth. Expose to direct sunlight for an hour or more. Pick the leaves which were covered, take off the cloth, and place the leaves in hot wood alcohol to kill the protoplasm and dissolve the green coloring matter. When free from green color, wash the leaves and place them in a solution of iodine to test for starch.

Observation: What evidence do you find of the presence of starch in any part of the leaf?

Conclusion: Why do we place the plant in the dark at the beginning

of this experiment? What effect does sunlight have upon green leaves? How do you know? What effect does absence of light have?

Application: When we eat potatoes, corn and rice we derive heat and energy from them. Trace this energy back to its original source.

The leaf a food manufactory. — If a green plant is kept in the dark for a long time the leaves lose their healthy

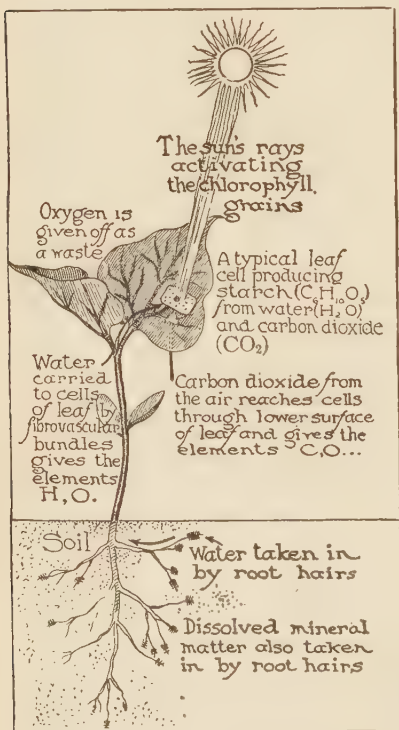
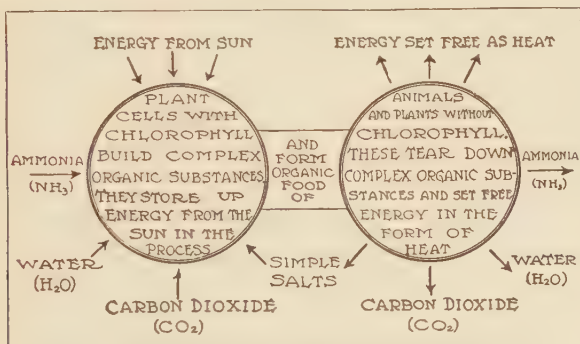


Diagram to illustrate the formation of starch in a leaf.

green appearance. A test for starch in one of the leaves shows that little or none is present. But if the same plant is placed in sunlight for a few hours and then a leaf is tested with iodine, starch will be found. This experiment shows that the green leaves of plants act as factories, in which sunlight supplies the energy which runs the machinery. The green coloring matter in the leaf, under the influence of sunlight, changes carbon dioxide of the air and water of the soil into sugars and starches. The mineral salts and carbon

compounds are used to make proteins and the living matter from which the plant is formed. In addition to this, green plants during the process of starch making

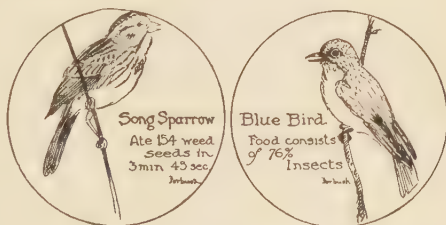
give off oxygen to the air as a waste. Of course, since they are alive they use oxygen the same as animals to oxidize foods within their bodies. This process, which we



The relation between green plants and animals.

call *respiration*, takes place in all living things. But it must not be confused with the process of starch making or *photosynthesis* in the green parts of a plant. During this latter process carbon dioxide is used and oxygen is given off as a by-product.

How green plants help a community.—You understand the im-



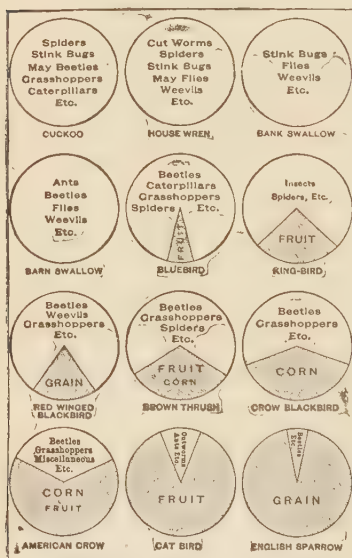
Two valuable garden birds.

portance of the work of green plants better now. Not only are they the food makers for animals but they also help to purify the air by using carbon dioxide and giving off oxygen. Thus we see that city parks are places for breathing as well as for recreation. Green trees are

an asset to any community for they provide shade, resting places for birds, and beauty to streets and parks.

The relation of birds to gardens. — We are apt to think in unfriendly terms of the robin or the crow when we make a garden. But the little harm that they may do is

more than offset by the help given to us by them and other insect-eating birds. A careful study of the accompanying figure shows conclusively that the two greatest enemies of the garden, insects and weeds, are fought by most birds. While the imported pest, the English sparrow, and a few others do eat cultivated fruits and grains, still the farmer and the gardener would have hard work to raise any crops at all were it not for the assistance given by birds. We should



Food of some common birds. Which of the above birds should be protected by man and why?

do everything in our power to attract and protect the birds. Put up bird houses and bird baths, feed those friends which winter with us and above all keep away prowling cats. It is estimated that cats destroy nearly 100,000,000 birds in this country every year. Why not provide the family cat with a collar bell during the summer months? It would save the lives of a good many useful birds every season.

Other friends of the garden. — Insects fortunately are not all harmful. Many aid in the formation of seeds by carrying pollen from one flower to another. Bees in particular should be encouraged to visit gardens because they carry pollen. Some beetles are of use as garden friends, especially the “lady bug” or lady bird beetle, which feeds upon plant lice or aphids. A few insects feed upon weeds and they can be classed as friends. We do not



The common toad, an insect eater.

think of a toad as being a beautiful animal, but every boy and girl who keeps a garden should have one living under the big-leaved plants in it. Toads have been found to eat no less than eighty-three different kinds of insects, most of which are injurious.

Insect pests. — Everybody who has a garden knows that sooner or later he must expect to find insects harming it. The damage which they do to all kinds of living trees and plants in the United States in a single year is estimated at over one billion dollars. Since we must expect

insect pests, the best way to prevent damage is to watch for them, and to get rid of them before they become numerous. If we remember that most insects lay eggs on the plants on which the young will feed later we can be on the watch for their eggs, and remove them before they hatch. Get the habit of looking for pests while weeding and cultivating your garden.

Experiment. — To study the life history of the cabbage butterfly.

Life history of insects. — If we should watch the life of an animal from the time it begins to develop until it becomes an adult and finally dies we would see its life history. Insects are segmented animals with three body regions. They have usually four stages in their life history. The egg is the first stage, often laid on a plant upon which the young will feed. This stage is followed by one known as the larva, during which the animal feeds and grows rapidly. Familiar examples of larvae are the caterpillars we see eating our garden vegetables, or the maggots in decaying meat. After the larva has shed its skin



POTATO BEETLE

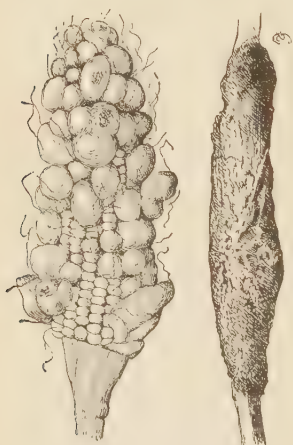
CABBAGE BUTTERFLY

several times and grown to its full size, it settles down and becomes quiet for a period. This is known as the pupal stage. Finally the adult insect breaks out from the pupa, and lives a relatively short life, during which its eggs are laid, and the life history or life cycle begins over again. Much harm is done in gardens by insects in the larval stage, as for example by caterpillars, cutworms, wireworms, and the like. A great many insects in the adult stage also do damage by sucking juices from plants. Such are bugs, which are recognized by their long sucking beaks. The seventeen-year locust, the chinch bug, and the squash bug, are good examples. Other adult insects such as the locusts, commonly called grasshoppers, do much harm by eating the young leaves of grass and vegetables which make up their food.

Some insect pests and how to fight them. — Since the insect pests in our gardens prefer certain foods, only one or two kinds of insects will attack each plant. These paragraphs are not intended to give you more than a hint as to the insects and the way to destroy them. You will be interested to make a home project of the disposal of the pests, and refer to the lists of bulletins and books given at the end of this chapter. You should always remember that poisons injure younger brothers and sisters, as well as insects. Keep all spraying solutions, and other poisons, well out of the reach of children, and exercise care and common sense in using them. The list on page 494 of garden vegetables with their pests, and methods of fighting them, will be found useful.

Plant enemies in the garden. — While green plants make food for themselves, and for the world about them, other colorless plants do a great deal of harm. Some of

VEGETABLE	INSECT	PREVENTION AND CURE
String beans	Aphids (plant lice)	Since these spread from weeds to beans, keep the weeds and other plants near the garden cut. Spray with kerosene emulsion or tobacco water.
	Bean weevil } Bean beetle }	Use same spray as above.
Cabbage	Plant lice	Soap emulsion or tobacco water.
	Cabbage worm	Use Paris green and pick off the worms.
Cauliflower	Cabbage borer	Use same methods.
	Cabbage worm	Use Paris green and pick off the worms.
Corn	Army worm (travels in large numbers)	Dust with Paris green, or if numerous, kill by means of kerosene.
	Corn root worm	Practice crop rotation.
	Drill worm	Crop rotation.
	Cutworm	Cutworms attack the silk and eat the end of cob. Spray with arsenate of lead.
Cucumber	European corn borer	Report to state authorities; they will tell you what to do.
	Cucumber beetle	Dust with ashes and use Paris green.
Potato	Potato beetle (bug)	Watch plants and pick off eggs or young beetles early. Spray with lime-Paris green.
	Slugs	Spray with Paris green or arsenate of lead.
Squashes	Squash borer	Burn vines, practice crop rotation. Kill young with kerosene.



Corn smut. Black knot.
(After Mayne and Hatch.)

these, called *fungi*, are molds, rusts, smuts, scabs, and other plant diseases. We find, for example, rust on asparagus, beans, and some other plants. Black rot is another plant enemy and grows upon beets and cabbages. Blights are formed on celery, cucumbers, tomatoes, and other garden vegetables. Still another serious plant enemy is the scab of potato. All these fungi live at the expense of various green plants, and make them wilt, the leaves curl up, or some other

symptom of disease occur. For all of these fungous diseases, a very excellent cure is Bordeaux mixture, which is best applied in a spray.

Use of the cold frame and the hotbed. — An excellent home project would be the construction of a hotbed or cold frame. Cold frames enable us to get a much longer period for growing vegetables. In the early spring they are especially useful to raise parsley, lettuce, and radishes



Cold frame.

for the table. They give tender plants, as tomatoes and peppers, protection from the cold. A cold frame could easily be manufactured by taking an old storm window or any other small window as a top, and fitting it over a frame made of boards nailed together to form a rectangle. The frame is simply a box without a bottom, set into the ground. Prepare the soil in this box with special care, using manure, and breaking the soil up into fine particles. Seeds planted under glass will grow rapidly because of the heat which is retained by it, and if the frames are covered up with thick cloths or blankets at night, plants begin to grow two months earlier in the spring and continue

two months later in the fall. The hotbed is a deeper box having a bed three feet deep. The lower part is filled with manure, which is allowed to heat and is then reopened, being tested from day to day until it reaches a temperature of 80° F. Cucumbers, lettuce, muskmelons, and tomatoes may be started in the hotbed, and transferred later to the

SCORE CARD. HOME OR COMMUNITY GARDEN¹

	SCORE	
	Perfect Score	My Score
General appearance	2	
Arrangements of rows	3	
Freedom from weeds	3	
Cultivation and care	2	
Choice of vegetables		
For home use	5	
For canning	5	
Freedom from pests		
Spraying for insects or disease when needed	5	
Other remedial measures if needed	5	
Evidences of		
Continuous cultivation	3	
Crop rotation	2	
Care of tools	5	
Value of produce		
Used at home	4	
Sold in the market	2	
Used for canning	2	
Accuracy of garden records	2	
TOTAL	50	

¹Modified from General Leaflet No. 10, United States School Garden Army Bureau of Education, Washington, D. C.

outside. To have the hotbed successful, it should be banked on the outside with manure in order to keep the heat in, and covered at night in cold weather with old rugs or mats in addition to the sash.

Score card of the garden. — It is not in the country only that school gardens flourish. Very many city boys and girls have an opportunity to compete with those in the country in the home garden project. It will interest you all to know that if you score high in this project you ought to belong to some of the state or city school garden associations. Perhaps you do — and perhaps you have already received an award from them. If not, why not try for it next summer?

REFERENCE BOOKS

- Corbett, *The School Garden*, U.S. Dept. Agriculture, Bulletin 218, also Farmers' Bulletins 154, 225, 408.
- Duncan, *Home Vegetables and Home Fruits* (For garden project). Charles Scribner's Sons.
- Food Supply in Families of Limited Means*. League for Preventive Work, Boston, 1917.
- Forbush, *Useful Birds and Their Protection*. Massachusetts Board of Agriculture.
- Hodge, *Civic Biology*, Chapters IV, XII, XIV. Ginn and Company.
- Hodge, *Nature Study and Life*, Chapter XVI. Ginn and Company.
- Hunter, *A Civic Biology*, Chapters VI, VII. American Book Company.
- Hunter, *Laboratory Problems in Civic Biology*, Chapters VI, VII. American Book Company.
- Jackson and Daugherty, *Agriculture through Laboratory and School Gardens*. Orange Judd Company, N. Y.
- King, *The Soil* (For teachers). The Macmillan Company.
- Lyon, *Soils and Fertilizers* (For teachers). The Macmillan Company.
- Mayne and Hatch, *High School Agriculture*, Chapter II. American Book Company.
- Merriman, *Birds of Village and Field*. Houghton Mifflin Company.
- Moore and Halligan, *Plant Production*, Chapter XIII. American Book Company.
- Rexford, *The A B C of Gardening* (Flower gardens). Harper and Brothers.
- Sanford, *The Story of Agriculture in the United States*. D. C. Heath and Company.
- Spellman, *Farm Science*, Chapter IV. World Book Company.
- Trafton, *Science of Home and Community*. The Macmillan Company.
- Transeau, *Science of Plant Life*, Chapter IV. World Book Company.

498 PLACE OF GARDENS IN THE COMMUNITY

The Small Vegetable Garden, U.S. Dept. Agriculture Farmers' Bulletin 818.

U.S. Food Administration, *Food and the War*, Chapter XIII. Houghton Mifflin Company.

U.S. Dept. Agriculture, *Farmer's Bulletins*. (There are very many of these, each treating a definite insect pest, or dealing with a definite fungus.) Ask to be placed on the mailing list for the monthly list of bulletins. Then you may select and send for those which interest you.

Webster, *Value of Insect Parasitism to the American Farmer*. U.S. Dept. of Agriculture Yearbook, 1907.

Weed, *Farm Friends and Farm Foes*. D. C. Heath and Company.

CHAPTER XXXI

IMPROVEMENT OF LIFE ON THE EARTH

Problems. — 1. *To learn how man handed down knowledge.*

2. *To learn how plants and animals have been domesticated.*

3. *To understand the laws of animal and plant breeding.*

4. *To know something of Gregor Mendel and his law of inheritance.*

5. *To understand the significance of the work done by some great investigators in heredity.*

6. *To understand why "blood will tell."*

7. *To understand the meaning of eugenics and euthenics.*

Suggested project. — 50. To make a study of heredity in my own family.

The beginning of civilization. — We have told already the story of man's early life on the earth. It is indeed a far cry from the cave man, living by the strength of his arm and spear, to the civilized man of to-day. We have progressed greatly and the civilized earth is a much better place for habitation than it was in the days when man wandered without a fixed abode. It is also a much safer place than in the days of Greece and Rome with all their vaunted civilization. What has brought about this great change in man?

Man learns from experience. — One of the ways in which man differs from the lower animals is that while

animals can learn from experience they cannot teach others, as man can. A little chick, for example, just out of the shell, picks at a badly tasting worm and gets an impression that lasts it through life. It will probably never pick up such a worm again. But all other chicks will have to learn this over again for themselves.



This shows how an Australian native kindles a fire. Our remote ancestors used similar methods. Some American Boy Scouts can kindle a fire in this way.

On the other hand, man learns not only to profit by experience but also to teach what he has learned to others and thus pass the knowledge down to the next generation.

Knowledge that concerned the making of fire. — The making of fire was so important a process that it was doubtless considered in the relation of a

religious rite or ceremony, and by such means it was impressed upon the youths of the tribe. The boys of the tribe



Primitive stone tools and weapons.

learned from their fathers how to make spears, bows and arrows, and nets with which to catch fish. Women in primitive life doubtless did all of the household work. They per-

haps first used wild rice or other cereals, planting seeds and tilling their small fields in order to keep body and soul together when the hunting and fishing gave no return. Necessity doubtless prompted them to make vessels of soapstone or other soft stone in which they could cook. They learned to use fibers and weave them into rude clothes when skins were not obtainable. They raised their children and taught them the same things that they had learned to do.



Primitive "household" work.

How civilized life has developed. —

Early in the life of man the clan or tribe played an important part. Gradually people began to live together in communities for mutual protection. Inhabitable areas began to be occupied by more and more people. Regions of fertility were seized by clans or tribes. Wars followed thus for the possession of these desirable areas or in defense of them by the people who already lived there. All this led to strong tribal feeling. It led also to another development — that of the strong man in the tribe being leader or chief, and from this came the further custom that the son of the chief ought to continue in power. Thus government by a few rather than by many developed.

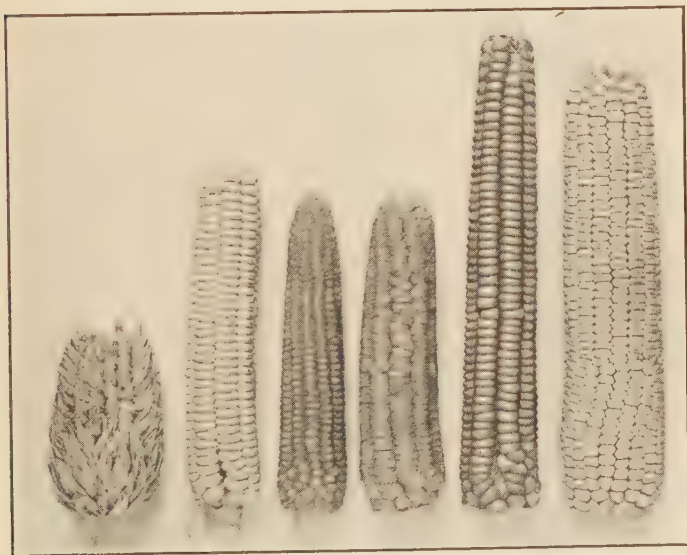
The domestication of plants and animals by man. —
It was a long step toward civilization when primitive peoples began to plant wild grasses and grains, for this

gave them permanent abiding places and stores of food to subsist on when the hunting was poor. Wheat, for example, was cultivated in Europe probably as far back as the stone age, by people who knew only enough to make instruments of stone. Rice was domesticated by the Chinese, centuries before Solomon reigned in Jerusalem. And the potato, which probably existed in a wild form in Chili, was used for food there long ages before the Spaniards came to America. Dogs, horses and cattle were all tamed and domesticated by man long before the dawn of civilization. With the development of modern life, the improvement of plants and animals has kept steady pace.

Two facts noticed by plant and animal breeders. — For a good many centuries men interested in breeding plants and animals have noticed two important facts concerning them, namely: with both plants and animals the offspring of the same species are alike and yet each is a little different from the others produced. Any boy or girl in this class can observe these same facts. If you will go out into the garden some morning and look at a row of pea or bean plants you will notice that they are all very much alike. They have the same shaped leaves, the same general appearance of stem, the pea or bean pods will be more or less of the same color and appearance, and the seeds will be alike generally in shape, size, or color. If you were to plant these seeds they would produce more plants like those from which the seeds came. This likeness of offspring to parent is due to what we call *heredity*. But if you were to examine the plants more closely you would find that each one is slightly different from its neighbor. They differ in the tallness or shortness of

the stem, in the size of the pod, in the number of peas or beans produced in the pod, and in a hundred other ways which can be detected only by fine measurements. This tendency to differ among plants and animals is called *variation*.

What Charles Darwin saw. — Breeders until the middle of the last century about the time of Charles Darwin,

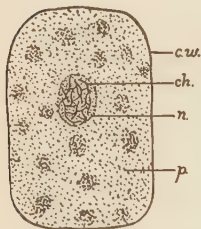


Types of corn. From left to right: pod corn, soft corn, pop corn, sweet corn, flint corn, dent corn. (After Moore and Halligan.)

used more or less haphazard methods in working for new varieties of plants and animals. Darwin noticed that in nature the variations which seem to fit an organism for its own environment were the ones handed down to another generation. Darwin thought if nature thus seized upon favorable variations, man could select favorable

variations also, and by care breed for those characteristics which he desired. Such artificial selection is seen in everyday farming. The boy or the girl who belongs to a corn club and who selects the best corn for planting by means of testing is practicing artificial selection. By means of selective planting such as this the farmers have put millions of dollars each year into their pockets and have made the cereal crops of this country known the world over.

What causes plants and animals to breed true. — We have seen already that plants and animals are made of cells. These cells are of two kinds, the ordinary ones of the body which give rise to stems, leaves and roots of plants or to the flesh and blood of animals, and another kind of cells known as the *sex* or *germ* cells which are set apart at a very early stage in the life of the plant or animal and are the bearers of what we call hereditary qualities. It

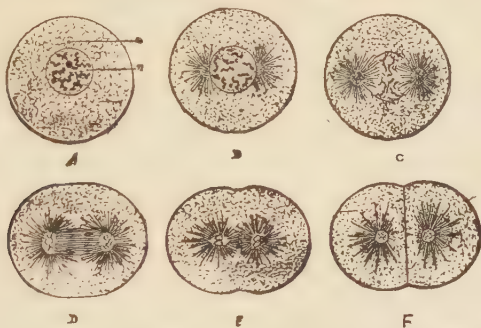


A cell. *c. w.*, cell wall; *n.*, nucleus; *ch.*, chromosomes; *p.*, protoplasm.

has been pretty well determined by means of careful experiments that the tiny structures we call *chromosomes* within the *nucleus* of the sex cells contain the *determiners* of the qualities which are passed from parent to offspring.

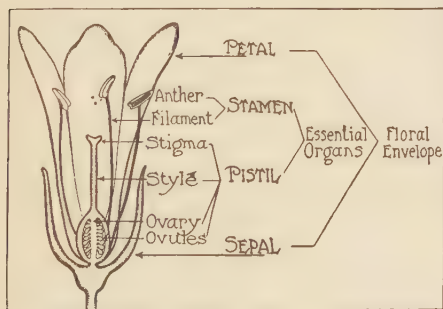
Where are the germ cells found in plants? — Surely every boy and girl has seen a flower and noticed a yellow dust called pollen which is produced in little box-like structures carried on stalks (called *stamens*, see diagram). In the very center of the flower is another stalked structure, called the *pistil*, with an enlarged base called the *ovary*. The stamens produce the sperm cells and the ovary pro-

duces the egg cells. Under certain conditions, a pollen grain containing a sperm cell is deposited on the end of

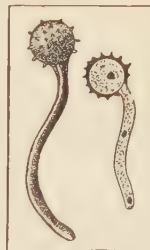


Stages in the division of one cell into two. The nucleus divides first: the chromosomes split and the parts go in equal numbers to each of the new cells.

the pistil in the same flower or on a pistil in another flower of the same kind. Here, the pollen grain develops a



Parts of a flower.



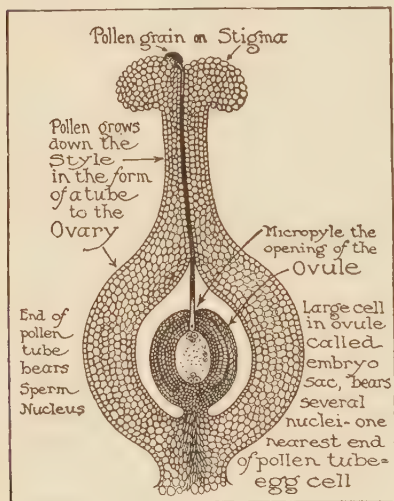
Pollen grain and tube. Section on right shows sperm nucleus passing down the tube.

long tube which allows the sperm cell to reach the ovary and unite with an egg cell.

Experiment. — To study cross-pollination in flowers.

Cross-pollination. — Pollen will germinate on flowers of the kind on which it grew, and rarely on those which are

nearly related to it. The bee, therefore, when it takes pollen on its hairy legs and body from one flower to another



Fertilization of a flower.

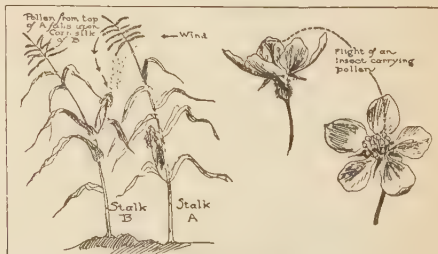
of the same kind transfers the pollen grains to a place where they can germinate. This process is called *cross-pollination*. It has been found by biologists that plants are usually healthier and stronger if they grow from seeds developed in flowers which have been fertilized by grains of pollen brought from the anthers of other flowers rather than fertilized by pollen from

the anthers of the same flower.

Some ways in which cross-pollination is brought about.

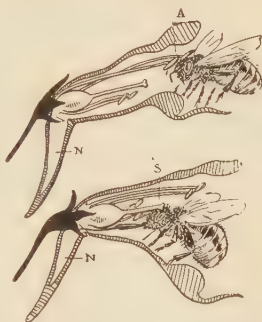
—It would take a long chapter to tell of all the structures which nature has devised in order to bring about cross-pollination. Flowers have different forms, often making attrac-

tive footholds for insects so that they will come to visit and carry pollen from one flower to another. Bright



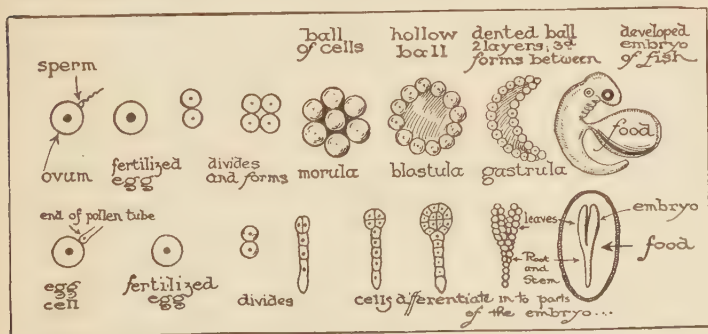
Cross-pollination.

colors are means of advertising to the insect that the flower contains nectar and pollen. Often a sweet odor plays an important part in attracting the bee, and some flowers which are pollinated by flies have an unpleasant odor almost like rotting meat. Frequently flowers have remarkable devices such as are shown in the illustration, which enable them to be sure of either self- or cross-pollination. Besides, insects, birds, wind, water, or man himself may be a means of carrying pollen from one flower to another.



Notice that the bee's head rubs against the anthers (A) and later against the stigma (S) as he presses forward to secure the nectar (N). How may this aid in self-pollination? If the bee visits other flowers of the same kind, might cross-pollination result? Explain.

The development of an embryo.—After the egg cell has united with the sperm cell a single cell is formed, but almost immediately this cell divides into two, then these two into four, these four into eight, and so on,



Sex cells of plants and animals develop into embryos.

until within the seed a little baby plant or *embryo* is formed. This embryo remains dormant until a time when the seed is

placed in favorable conditions for germination or growth. We know that plants in the garden require a certain amount of warmth, water, and soil. Under these same conditions the baby plant within the seed is awakened to activity and starts to grow. Eventually it will produce flowers, and if the egg cells in them are fertilized these flowers will produce fruits containing seeds. These seeds in turn will give rise to new plants.

Development in animals. — Nearly every boy and girl has seen a mass of freshly laid frog's eggs. These eggs are laid in water in the early spring by the female frog. The male frog at that time places some sperm cells on the eggs. After an egg cell has been fertilized it develops into a little tadpole or baby frog. If you examine a mass of frog's eggs you will doubtless find them in the process of division. Just as in the flower, the fertilized egg divides first into two, then into four, then into eight, then into sixteen cells. These cells keep on multiplying until within a couple of days if the weather is warm the embryo of the frog begins to elongate. In another day the little tadpole wriggles out of the jelly in which the egg was placed and goes swimming about after food. Almost everyone knows that these little tadpoles after a time grow hind legs, then front legs develop, at the same time the tails are absorbed into the body and eventually the young frogs appear. Not until the female frogs are adults are they able to lay eggs and thus reproduce and perpetuate their own kind.

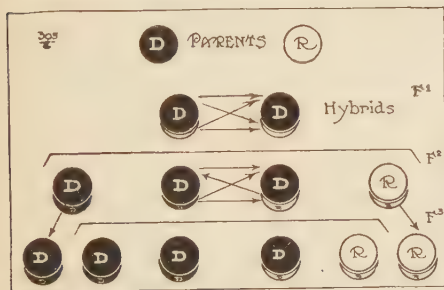
Gregor Mendel and his law of unit characters. — All these facts and many others were known to plant and animal breeders but it remained for an Austrian monk named Gregor Mendel to make a discovery which has

meant more than any other to those who are trying to improve plants and animals. Mendel, working with peas, found that the characteristics handed down from one generation to another were units, such as the color of the peas, the shape of the pods, and the tallness or shortness of the plants. Thus it appeared that hereditary qualities were in the form of unit characters.



This illustrates the law of dominance. Rough coat is a dominant characteristic.

The law of dominance. — He found also that one of these characteristics, when it appeared in the next generation, would take dominance over another and would occur more frequently in the offspring. In the picture rough-



This illustrates the law of segregation. Follow out the crossings of the D hybrids to the F³ generation. The proportion of hybrid to pure recessive is 3 : 1. Pure recessives will always breed recessives and dominants will breed dominants.

ness of coat is dominant over smoothness of coat in guinea pigs. The characteristic roughness is said to be *dominant* while the characteristic smoothness is said to be *recessive*.

The law of segregation. — When

Mendel bred yellow and green peas he found all the offspring had yellow peas in the pod. These peas were really hybrids, that is, they were the offspring of two parents which differed in respect to certain unit characteristics.

If these hybrids were bred with other hybrids of the same kind, in the next generation the offspring would be produced in the ratio of about three yellow to one green, or three dominant to one recessive. If the hybrid peas were bred with a green pea (a pure recessive), the offspring would be produced at the rate of about two dominant and two recessive. If the hybrid is crossed with a pea of the yellow variety (a dominant) then all dominants are produced in the next generation. This hereditary tendency is called the *law of segregation*.

Use of this knowledge. — Since it is quite evident that a knowledge of these laws is of very great importance to breeders, hundreds of biologists are trying to find out new dominant and recessive characteristics in plants and in animals, for it is only by a knowledge of these characteristics that intelligent breeding can take place. Much can be done with selection, and by means of a knowledge of Mendel's law it is quite possible for those who are trying to improve the existing plants and animals to breed for exactly those qualities that they wish. Therefore the dairyman breeds for greater milk and cream production, the hog raiser for heavier animals, the sheep grower for more and better wool, and the florist for larger and more beautiful flowers. Heritable traits in man as well as in plants and animals seem to be subject to these natural laws. One may therefore predict with some degree of accuracy the characteristics of children. Thus we see that the application of all this knowledge is of tremendous consequence to the future of the human race.

Demonstration Experiment. — To show how hybridizing is accomplished.

Materials: Plants bearing flowers. A manila bag. A camel's-hair brush.

Method: Tie a manila bag over a flower that is about ready to open. Find another flower that is about to open, on a plant of the same family though another variety or preferably another species, and from that flower remove all the stamens. Tie a bag over it also. Why?

When the flower in the first bag opens transfer by means of a small camel's hair brush some of its pollen to the stigma of the flower without the stamens. Put the bag over the second flower again, placing a label on it. Give all of your data.

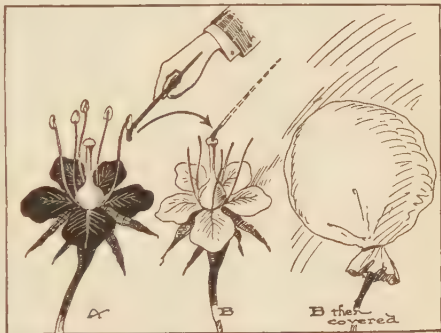
Observations: Why do we take so much care in covering the flower?

Why such care in the transfer of pollen?

Remember that as a result of this transfer the sperm cell of one flower may unite with the egg cell of another having quite different qualities.

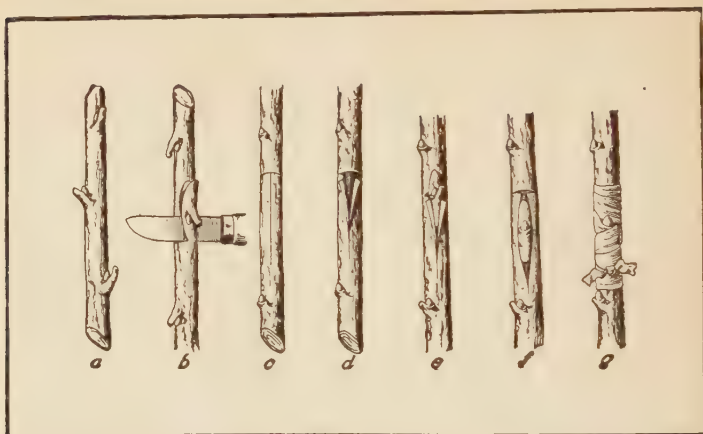
Conclusions: What is the use of hybridization?

Application: How might Luther Burbank have "created" new forms of plant life by this method?

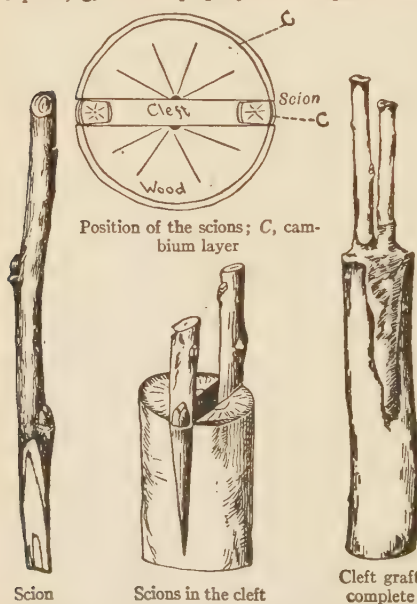


Transfer of pollen in hybridization.

The work of some practical breeders. — In this country the name of Luther Burbank stands prominently as a great creator of new forms of plant life. Burbank uses selection with crossing or *hybridization* in order to obtain his wonderful new fruits. He selects with great care some plants of near relationship showing the unit characters he wishes to perpetuate. He then carefully covers a flower bud on one of these plants and at the proper time cuts off the stamens before the pollen is produced. Then he carefully dusts the stigma of the pistil with pollen from another plant which has the qualities he wishes to cross



Steps in budding. *a*, twig having a suitable bud to use; *b*, method of cutting out bud; *c*, how bark is cut; *d*, how the bark is opened; *e*, inserting the bud; *f*, the bud in place; *g*, the bud properly bound in place.



Scion

Scions in the cleft

Cleft graft complete

Grafting. The scion is taken from a tree having the kind of fruit desired and placed in a tree of the same species as suggested above.

with the first plant. If these two plants are near relatives it is likely that the pollen will grow and a new variety will be produced which may show the desired characteristics. These methods are used also by the various state departments of agriculture and by the experiment stations of the U.S. Department of Agriculture. Still another method is to watch for sudden "mutations" or

discontinuous variations which are quite different from the parent plants and which breed true. Still another way of producing desired plants is by budding or grafting. A study of the diagrams will explain how a bud from a plant bearing the desired fruit can be made to grow on another plant. It is said that all the seedless oranges were produced from a single orange tree which bore oranges without seeds.

Triangle of life. — A good deal has been said and written upon the question, "Which is the more important for a person, his heredity or his environment?" As a matter of fact the life of each one of us is influenced by three great factors; these are *heredity* or what we are, *environment* or what we have, and *training* or what we do. We have read in the previous chapters of this book how important our environment is and how much is being done to improve it. In the first part of this chapter we have



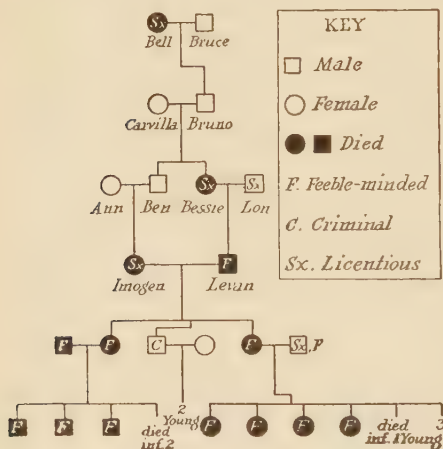
The triangle of life.

seen how important training has been and still is in the lives of people. Let us now ask ourselves the question, "What part does heredity play in our lives?" Knowledge that the race is gradually changing, that there is a constant growth or evolution makes us ask, "Can these laws of heredity of which we have just learned be applied to the human race?"

Improvement of the human stock. — It is quite evident from what we have read in some of the previous chapters that through personal hygiene, and improvement of the

environment, a healthier and stronger race has been brought about. But if we study the records of some of the royal families, of certain well-known families in this country and Europe, and of other families which through misfortune have become a burden on society, we find that *breeding* in man must be taken into account as well as in plants and in animals.

The heredity of civilized man. — A number of years ago there lived in an isolated part of New York state a



The family pedigree of the "Jukes" family.

family of ne'er-do-wells. This family, known as the Jukes, has been carefully studied. Up to 1915 there were 2094 members. Of this number 1600 living at that time were feeble-minded or epileptic. There have been 310 paupers; over 300 immoral women; 140 criminals, of

whom 7 were murderers; not a soldier had appeared in the family and not one had a common school education. Only 20 had learned a trade and 10 of these learned it while in prison. The family has cost society over \$2,500,000 up to the present time. And why? Because the original stock was feeble-minded and intermarriages have handed down the feeble-mindedness to other generations. Feeble-mindedness is thus seen to act as a recessive Mendelian

characteristic, and, as a study of the diagram shows, if one feeble-minded person marries another all their offspring are sure to be feeble-minded.

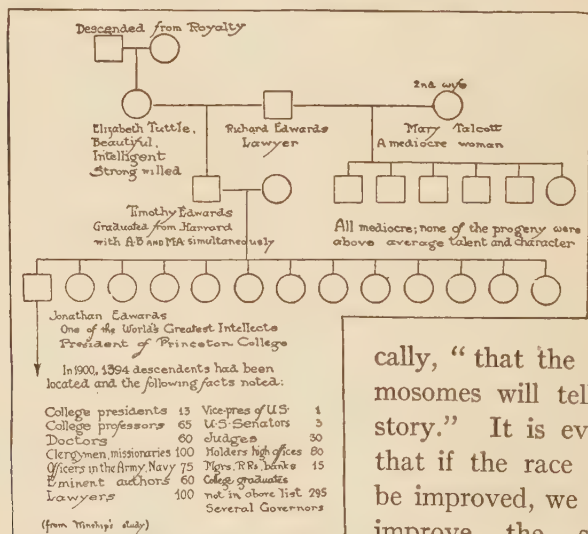
Parasitism and its cost to society. — If this were but one case it would be bad enough, but there are over 650,000 feeble-minded persons in the United States to-day. These persons spread disease, crime, and immorality in all parts of the country, chiefly because they know no better. Just as certain plants or animals become parasitic on others so these people have become parasites on society. They take from society but they give nothing in return. In the valley of Aosta (Italy) a few years ago there existed a number of idiotic folk known as cretins. Probably over fifty per cent of the inhabitants of this little mountain valley were so affected. But thanks to wise planning these idiots were segregated, the males in one asylum and the females in another. Since that time the race of cretins has gradually died out and one scarcely ever sees any of them now. This is the only means by which feeble-mindedness can be eventually blotted out from the earth.

Experiment. — To determine some means of bettering the human race physically and mentally.

The inheritance of moral and mental characteristics. — Fortunately, the bad side of heredity is not the only one. A study of certain distinguished families has proved that genius and mental traits are also handed down. An interesting example is seen in the Darwin-Wedgewood family in England. In five generations of this family out of 24 men 17 have been noted in science or in letters. In this country the Jonathan Edwards family has been a notable example. Out of 1394 descendants there have

been 13 college presidents, 75 army officers, 100 lawyers and ministers, more than 60 authors, 60 physicians, 295 college graduates, and not a single pauper.

The meaning of eugenics. — The above paragraphs show us that blood will tell or rather, to put it scientific-



cally, "that the chromosomes will tell the story." It is evident that if the race is to be improved, we must improve the stock.

The family pedigree of the Edwards family.

This is to be done in the same way that we work on animals or plants, that is, we must check the reproduction of the poorest strains and mate the individuals of the strongest stock. *Eugenics* is the science of improving the human race by better heredity.

The meaning of eugenics. — People all over the civilized world have a much better chance to-day than those of a few years ago. The housing conditions as late as 1850 in London and other large cities were disgraceful but they are now being remedied gradually. For example, a report by Dr. Havelock Ellis tells us that in one of the

slums of London, a part called Bethnal Green, in 1848 many of the workmen's homes were mere huts, small houses or sheds never intended for human habitation. There were thirty-three miles of streets and more than one hundred miles of by-ways, only a few of which were paved. There were few if any sewers. Refuse and filth were dumped into the street and accumulated there, for the entire street-cleaning department of this part of London consisted of thirteen worn-out old men who could just about cover the territory every three months. It goes without saying that with such conditions pestilence and death stalked hand in hand. A few years ago child labor was permitted everywhere and amounted to virtual slavery in many places. Children worked long hours under conditions which were unfit even for pigs. But to-day laws have been made which prevent, at least in part, such unfair treatment of children. Civilized society would not permit the conditions which formerly existed in the London slums.

A city which allows foul tenements, narrow streets, and crowded slums to exist will spend more than its share for police protection, for charity, and for hospitals. Science is helping man through coöperation in the saving of human lives, in better sanitation and hygiene in the home and in the community. It is showing us better methods of work in the hospitals and in the sanatoriums. It is giving us better prisons and methods of dealing with prisoners. It is making our teachers and physicians better equipped and more capable of coping with problems based on science; it is making our school children more thoughtful of the health rights of others. *Euthenics* is the science of the betterment of the environment. It is another factor in the development of a stronger and healthier race. The

world is growing better in spite of what pessimists believe. It is gradually becoming a safer and healthier place in which to live. The lives of children are now safeguarded by purer milk and better housing, by means of public nurses and dispensaries. Our schools are more useful and more adaptable. Our laws on child labor are more comprehensive and helpful. Above all, both children and parents are becoming better educated in the duties of good citizenship and healthier living. May this book do its part toward helping in this great work.

REFERENCE BOOKS

- Bailey, *Plant Breeding*. The Macmillan Company.
 Caldwell and Eikenberry, *General Science*. Ginn and Company.
 Conklin, *Heredity and Environment*. (For teachers.) Princeton University Press.
 Coulter, *Fundamentals in Plant Breeding*. (For teachers.) D. Appleton and Company.
 Davenport, *Heredity in Relation to Eugenics*. Henry Holt and Company.
 Downing, *The Third and Fourth Generation*. (For teachers.) University of Chicago Press.
 Estabrook, A. H., *The Jukes in 1915*. Carnegie Institute, Washington Publication Number 240, 1916.
 Gibson, *Blossom Hosts and Insect Guests*. Newson and Company.
 Goddard, *Feeble-mindedness, Its Causes and Consequences*. (For teachers.) The Macmillan Company.
 Goddard, *The Kallikak Family. A Study in the Heredity of Feeble-mindedness*. The Macmillan Company.
 Gruenberg, *Elementary Biology*. Ginn and Company.
 Guyer, *Being Well Born*. Bobbs-Merrill Company.
 Harwood, *New Creation in Plant Life*. The Macmillan Company.
 Hodge, *Civic Biology*. Ginn and Company.
 Hunter, *A Civic Biology*. American Book Company.
 Hunter, *Laboratory Problems in Civic Biology*. American Book Company.
 Jewett, *The Next Generation*. Ginn and Company.
 Jordan, *The Heredity of Richard Roe*. American Unitarian Ass'n.
 Moore and Halligan, *Plant Production*. American Book Company.
 Richards, *Euthenics, The Science of Controllable Environment*. Whitcomb and Barrows.
 Wilson, *The Cell in Development and Inheritance*. (For teachers.) Columbia University Press.
 Woods, *Mental and Moral Heredity in Royalty*. (For teachers.) Henry Holt and Company.

INDEX

NOTE :— Numbers in heavy faced type refer to pages containing illustrations as well as descriptive text.

- Absolute humidity, 290
- Accidents, prevention of, 388
- Accommodation, of lens, 177
- Adenoids, 58
- Adulteration of foods, 338
- Aedes, 364
- Aërobic, 105
- Agriculture, Department of, 512
- Air, 44, 245
 - composition of, 45
 - ocean of, 43, **44**
 - pressure, 50, **67**
 - pure, 48
 - reality of, 44
 - relation to health, 113
 - saturated, 290
 - weight of, **49**
- Air passages, diseases of, 58
- Airplanes:
 - forerunners of, 453
 - invention of, 454
 - lifting force, speed, and power of, 458
 - present and future of, 460
 - rise and fall of, 459
 - stability of, 459
 - support of, 456
 - types of, 456
- Airships or dirigibles, **452**
- Alternating current, electric, 378, **379**
- Ammeter, 210
- Ampere, 210
- Amusements, home, 225
- Anaërobic, 104
- Anopheles, 14, 362
- Animals, heredity in, 508
- Anticyclone, 282
- Anti-fly campaign, 358
- Antitoxin, for diphtheria, 113, **355**
- Arc lights, 381
- Arteries, 98
- Artesian wells, **64**
- Artificial gas, manufacture of, 373
- Ashes, disposal of, 350
- Astigmatism, 180
- Atlantic cable, 468
- Atmosphere, 44
- Atmospheric pressure, 50
- Automobile, 425, 435
- Bacteria, 88, 89, 109
 - aërobic, 105
 - anaërobic, 104
 - bacillus, 110
 - coccus, 110
 - conditions favorable and unfavorable for, 90, 91
 - culture medium of, 56
 - relation to food, 89
 - relation to soil, 486
 - spirillum, 110
 - types of, **110**
- Balloons, **450**, 451
- Barometer, 279, 280
 - aneroid, **280**
 - experimental, **279**
- Bathroom, modern, 36, **101**
 - flush tank, **102**
- Bearings, ball, **189**
- Bedroom, ideal, **33**
- Bees, relation to flowers, 506, **507**
- Bell, electric, 202
- Bifocal lens, 182
- Birds, value of, to gardens, 490
- Boats, **440**, 441
- Body:
 - composition of, 77, **78**
 - defense against diseases of, 112
 - poisons in, 115
 - relation to food of, 83
 - relation to heat of, 132
- Bread making, 87
- Breathing, 51, 52, 53
 - necessity for, 53
 - process of, 51
- Breeding, plant and animal, 502, 504, 514
- Brick, 31
- Bridges, 422
- Bubonic plague and fleas, 368
- Building materials, 28, **29**, 30, 31
- Buoyancy, 439
- Burbank, Luther, work of, 511
- Calorie, 83
- Camera, 176
- Canals, 446
- Candle, relation of air to, 45

- Canning foods, **90**
- Carbon, **124**
- Carbohydrates, **78, 80**
- Carbon dioxide, **45, 47, 54**
 - fire extinguishers, **157**
 - test for, **47**
- Carbon tetrachloride extinguishers, **157**
- Carburetor, **428**
- Carelessness, in relation to fire, **151**
- Caves, formation of, **72**
- Cells:
 - electric, dry, **201, 202**
 - joining of, **210**
 - wet, **201**
 - in living bodies, **504**
 - structure of, **504**
- Centrifugal force, **226**
- Cesspool, **100, 104**
- Chemical elements defined, **54**
- Chemical fire extinguishers, **157, 390**
 - section of, **158**
- Chemicals, used in water supply, **326**
- Choroid coat of eye, **177**
- Chromosomes, **504**
- Cistern, **63**
- Civilization, beginning of, **499**
 - development of, **501**
 - relation to climate, **275**
- Cleaning, vacuum, **205**
- Cleanliness, habits of, **118**
 - in kitchen, **93**
 - of dishes, **94**
- Climate and civilization, **275**
 - effect of one on the other, **275**
 - ideal, **293**
 - influence of water, **287**
 - influence on health, **292**
 - influence on industry, **289**
 - sunlight a factor in, **277**
- Clothing, wear of, **134**
- Clouds, **286**
 - and rain, **284**
 - formation of, **284**
- Coal, beds in the earth, **123, 124**
- Coal gas, manufacture of, **374**
- Coal range, **136**
- Coal stove, **137**
- Cold frame, **495**
- Cold storage, **336, 337**
- Colleges, **397**
- Color, **178**
 - in the home, **32**
 - nature of, **178, 179**
- Combustion, **46**
- Community:
 - control of common supplies, **252, 331**
 - control of disease, **347, 352, 354**
 - food supply, **331**
 - formation of, **270**
- Community:
 - government, **255**
 - history of, **259, 271**
 - ideal, **243**
 - planning, **254**
 - protection of food, **332**
 - resources, **272**
 - schools, **255, 395**
 - water supply, **317**
- Concrete, in road building, **410**
 - in house building, **31**
- Conduction, **131, 132**
- Cone clutch, in automobile, **434**
- Conservation of forests, **306, 307**
- Contagious disease:
 - fighting, **354**
 - recognition of, **353**
 - spreading, **352**
- Continental code, **476**
- Convection currents, **130, 132**
 - by hot stove, **138**
 - by hot water heat, **140**
- Cooking, **85**
- Crop rotation, **487**
- Crops, conditions favorable to, **309**
- Cross-pollination, **505, 506**
- Crowding, menace to health, **26**
- Culture medium, **56**
- Current, electric, **201, 209**
 - sources of, **201, 377**
 - wire resistance to, **209**
- Currents, convection, **130, 132**
 - direction of air, **55, 283**
- Cyclones, **281**
- Cylinder, in gas engine:
 - cooling of, **431**
 - number of, **434**
- Darwin, Charles, **503**
- Density, **438**
- Determiners, **504**
- Development, in animals, **508**
- Dew, **285**
- Diaphragm, **52**
- Diets, differences in, reasons for, **83**
- Diffusion, **72**
 - of light, **164**
- Digestion, **84**
- Digestive tract, **84**
- Dining room, ideal, **35**
- Diphtheria, **112, 113, 355**
- Direct current, electric, **379**
- Dirigible, **452, 453**
- Diseases:
 - bubonic plague, **368**
 - carried in milk, **336**
 - caused by germs, **110, 111**
 - communities fight, **347**
 - defenses of body against, **112**

Diseases:

- infected by saliva droplets, 111, **112**
- malaria, 360, **361**
- of air passages, 58
- relation of flies to, 356
- seasonal variation in, **357**
- yellow fever, 363, **364**

Disinfectants, 112

Dominance, Mendel's law of, 509

Drainage:

- home grounds, 66
- reclamation, 311

Drain pipes, home system of, 103

Drinking fountain, 398, 399

Driving, safe and sane, 389

Drugs:

- abuse of, 119
- dangers of, 343
- habit-forming, 343
- uses of, 119

Dry farming, 311

Dust, 48

- dangers of, 55, 56
- proper removal of, 57

Ear, 221, 222

Earth, age of, 262

- beginning of life on, 269
- early beliefs of, 262
- formation of, 260

Eclipses, 236

Edison, Thomas, 37

Education, 395, 397

- religious and moral, 405

Educational aids:

- art museums, 400
- libraries, 400
- moving pictures, 402
- religious and moral, 405
- schools, 255, 395

Edwards, Jonathan, family, 515, 516

Electric car circuits, 421

Electric current, 209

Electric lamps, 168

- types of, 380

Electric measuring instruments:

- ammeter, 210
- voltmeter, 209
- wattmeter, 214

Electric motor, 204

Electric railroad, 420

Electric units:

- ampere, 210
- kilowatt-hour, 214
- volt, 209
- watt-hour, 214

Electricity:

- bell, 202, **203**
- cells, 201, **202**

Electricity:

- circuit, 211, **382**
- current, 200, 209
- heating devices, 206
- in the home, 197
- iron, 206
- magnets, 200
- measurement of, 214
- motive power, 443
- pressure, 208
- production of, 378
- relation to lighting, **169, 170**
- resistance to, 207
- static, 201
- street lighting, 376
- toaster, 206
- toys, 226

Electromagnet, 201

Embryo, development of, 507

Energy, 162, 190

Engines:

- air-cooled, 431
- gas, 424
- locomotive, **418**
- steam, 415, **416**
- water-cooled, 431
- Watt's, 416

Environment, factors of, 43, 244

Enzymes, relation to digestion, 84

Erosion, methods of, 266

- by ice, **267**
- by water, 267, **268, 298**
- by wind, 268, **269**

Eugenics, 516

Euthenics, 516

Expansion tank, 140

Experience, as a teacher, 499

Expiration, in breathing, 53

Explosive mixture, 427

Extinguisher, fire, 157, 158

Extinguishing burning liquids, 157

Eyes:

- adaptability of, 177
- care of, 182
- change in pupil, **178**
- defects of, 179
- importance of, 174
- removing dirt from, 182
- section of, **177**
- strain, 182
- structure of, 176

Fainting, 60

Farming, dry, 311

Farsightedness, 181

Fats, in food, 78, 80

Faucets, leaky, 71

- types of, 70, **71**

Feeble-mindedness, 514

- Fertilization, **506**
 Filters, and filter beds, 322
 removal of impurities, 324
 Fire:
 alarm system, 391
 chemical extinguishers, 157, 390
 dangers of, 149, 153
 department, 389
 equipment, 389, **391**
 extinguishing, 155, 157
 flames for light, 153
 losses, 150
 making of, 130
 prevention of, 149
 protection, 392
 regulation of, 137
 regulations, 393
 smothering, 155
 sources of, 152, 154
 Fireless cooker, **86**
 Fire-making, 500
 Fleas, relation to bubonic plague, 368
 Flies:
 as disease carriers, 356
 breeding places, 106
 fighting flies, 107, 357, 358, 359
 habits of, 106
 life cycle of, **358**
 Floods, **288**
 regulation of, **297**
 Flowers, relation to bees, 506, **507**
 structure of, 507
 Flytraps, 107, 359
 Flywheel, use of, 417, 430
 Focusing, 174, **175, 228**
 Food:
 adulteration of, 338, 339, 340
 affected by bacteria, 89
 bulky, **114**
 carbon and water in, 77
 cold storage of, 336
 in a store, 337
 indigestible, **114**
 our need of, **77**
 plant origin of, 481, **488**
 preservation of, 90
 protection of, 332
 relation of health to, 113
 requirements of body, 83
 simple foods, **114**
 spoilage of, 86, 89
 Food and Drug Act, 338, 342, 344
 Foot pound, 189
 Force pump, **68, 69, 390**
 Forests, 272
 map of national, 307
 protection of, 306
 Fossils, 269, **270**
 Friction, rolling and sliding, 189
 Frogs, development of, 508
 Frost, 285
 Fuel:
 burning elements of, 126
 economy of, 125
 heating value, 124
 sources of, 123
 Fulcrum, 186
 Fungi, 494
 Furnace, hot-air, 138, **139**
 advantages and disadvantages of
 139
 Fuses, **213**
 Games, **28, 38**
 Garbage:
 disposal of, 99, 251, 350
 pails, 107
 reduction, 350
 Gardening:
 in community, 480
 value of birds to, 490
 Gas:
 advantages of mantle, 168
 artificial, 373
 burners and cost, **167**
 coal, 374
 in the home, 167
 manufacture of, 373, **375**
 meter, 145
 natural, for lighting, 372
 range, 143
 water, 376
 Gas engine:
 air-cooled, 431
 development of, 424
 gasoline engine, 428
 number of cylinders, 434
 water-cooled, 431
 Gasoline:
 engine, 428
 treacherous cause of fire, 155
 Gears, **191**
 Generator, 378
 Germ cells, 504
 Germ dangers, 109
 Germs (*see* Bacteria), 109
 growth of, 109
 how enter our bodies, 111
 Glacier, **267**
 Glass:
 importance of, 31
 making window, **31**
 Gneiss, **265, 266**
 Government, community, 255
 Grades, in a road, 414
 Granite, **266**
 Granite quarry, **29**
 Graph, **21**

- Gravity, center of, 439
 Grounds, 26
 Gyroscope, 226
- Health:
 body poisons and, 115
 climate and, 292
 exercise and, 38
 rest and, 117
 rules of, 38, 120
- Hearing, 221
- Heart, 97
- Heat:
 and temperature, 245
 distributing, 131
 from electricity, 206
 in cooking, 143
 in homes, 136
 loss from body, 132
 steam, 141, 142, 143
- Heliograph signaling, 463
- Heredity, 502, 513, 514, 515
- Home:
 duties of children, 37, 116, 117, 225
 efficiency in, 36
 environment of, 23
 grounds of, 26
 heating of, 136
 ideal score card, 40, 41
 model, 24
 recreation in, 38, 217
 regulation of light in, 166
 removal of wastes, 99
 requirements, 24
 scoring of, 39
- Horse power, 301
- Hospitals, 255
- Hot-air furnace, 138, 139
 advantages and disadvantages of, 139
- Hotbed, 495
- Hot-water heating system, 140
 advantages and disadvantages of, 141
 how a room is warmed by, 141
 principle of, 140
- Hot water supply, 144
- House, floor plans of, 32, 35
- Housing, 252
- Human energy and climate, 292
- Human race, improvement of, 513
- Humidity, 55, 290
- Hybridization, 511
- Hydrogen, 126
- Hygrometer, 290
- Ice, agent of erosion, 267
- Immunity, 113, 354
 antitoxin treatment, 113, 355
- Impervious layer, 63, 64
- Incandescent lights, 382
- Inclined plane, 193
- Inertia, 412
- Inheritance, 515
- Insect:
 as pests, 491, 493
 friendly, 491
 life history of, 492
- Inspiration, in breathing, 53
- Iris, 177
- Irrigation, 312
- "Jukes" family, 514
- Keokuk, 302
- Kerosene, lighting, 167
- Kilowatt hours, 214
- Kindling temperature, 129
- Kitchen, a model, 35
- Lamp circuits, 381
- Larva of fly, 106
- Larveran, 13
- Law and order, 385
- Lawn mower, 188
- Leaf, food manufactory, 488
- Legumes, 486
- Lens of eye, 177
- Lenses, 175
 focal lengths, 176
 use in focusing, 174
 uses of, 228, 232
- Letters, delivery of, 465
- Lever, 186
 classes of, 187
- Libraries, 399
- Life:
 beginning of, 269
 of early man, 270
 triangle of, 513
- Life saving, 59
- Lift pump, 67, 68
- Light, 246
 artificial, 166
 electric, 169
 natural, 163, 164
 surfaces diffusing, 164
 tungsten, 169
- Lighting:
 artificial, 166
 electric, 168
 gas, 167
 illustration of, 171
 kerosene, 167
 methods of, 171
 of streets, 370
- Living room, ideal, 34
- Loam, 269
- Locomotive, 418

- Lungs, capacity of, **53**
 relation to breathing, **53**
 wastes given off by, **54**
- Lymph tubes, **98**
- Machines:
 in the house, **185**
 law of, **190**
 mechanical advantage, **187**
 sewing, **195**
 washing, **195**
- Magnets, **198**
 electromagnets, **201**
 laws of magnetic poles, **199**
 magnetic fields, **199**
 properties of, **198**
- Mail service, **464**
- Malaria, **360**
 cause of, **361**
 cure for, **363**
 relation to mosquito, **362**
- Man, early life of, **499**
 heredity in, **514**
- Manganese dioxide, **202**
- Manson and Warren, **15**
- Manure heaps, a fly menace, **105, 106**
- Matches, **152**
 study of, **129**
- Mechanical advantage, **187**
- Mechanical toys, **226**
- Medical fakes, **344**
- Mendel, Gregor, **508**
 law of unit characters, **508**
 relation to heredity, **510**
- Meter, gas, **145**
- Microscope, **228**
 compound, **228**
- Microphone transmitter, **473**
- Milk:
 diseases carried by, **336**
 grades of, **334, 335**
 inspection of, **335**
 pasteurizing, **89, 336**
 tests, **335**
- Molds, fruiting bodies, **88**
 in the house, **88**
 spores, **88**
- Moon, **235**
- Morse, S. F. B., **465**
- Morse code, **468**
- Mosquitoes:
 Aedes, **364**
 Anopheles, **14, 362**
 community fighting of, **366**
 extermination of, **365**
 protection against, **366**
 relation to malaria, **362**
 relation to yellow fever, **363**
 standing water and, **107**
- Motor, electric, **204, 205**
- Moving pictures, **402, 403, 404**
- Muffler, of automobile, **434**
- Museums, **400**
- Musical scale, **222, 223**
- Music and noise, **222**
- Mutations, **512**
- Natural resources, **272**
- Navigation, **446**
- Nearsightedness, **180**
- Nebula theory, **260, 261**
- Negative, in photography, **229, 231**
- Newspaper, **477**
- Nichrome wire, **206**
- Nitrogen:
 in air, **45**
 cycle of, **485**
 related to soil, **485**
- Nodules, **486**
- Noise, **222**
- Nutrients, classification of, **78, 82**
- Opaque shade, **163**
- Ovary, **504**
- Oxidation, **47**
- Oxygen, **45**
- Parasitism, **515**
- Parks, **401, 402**
- Pasteur, Louis, **89**
- Pasteurization, **89, 335, 336**
 pasteurizing apparatus, **89**
- Patent medicines, **342**
- Periscope, **444**
- Phonograph, **223, 224**
- Photography, **229**
 enlarging, **232**
 printing, **232**
 taking a photograph, **230**
- Piano, **223**
- Pictures, **230, 231**
 enlarging, **232**
 printing, **232**
 sending, by wire, **477**
- Pistol, **504**
- Pitch:
 of screw, **194**
 of sound, **220, 221**
- Planets, **234**
 relative sizes, **235**
 distances measured, **237**
- Plants:
 domestication of, **501**
 friends of, **490, 491**
 pests of, **491, 493**
 relation of soil to, **485**
 root-hairs of, **485**

Playgrounds, **400**
 Plumbing, sanitary, 100
 Pneumatic tank system, 69, **70**
 Police:

modern system, 386
 patrol signal system, 388
 work of patrolman, 386, **387**

Pollen, **505**

Preservatives, harmful, 341

Pressure, of atmosphere, 50

Prisms, **179**

Projects, 17

list of suggested, 19, 20

Protein, 78, 79

foods rich in, **80**

Public schools, 395

Pulley, 191

Pumps, force, **68, 69**

lift, **67, 68**

Pupil, of eye, 177

Quarantine, 352

Radiant energy, 162

Radiation, 131

Radio, **472**

importance of, 476

Railways:

development in U.S., 419

electric, 419, 420

Rainfall map, 247

Rain water, 62

Rats, relation to disease, **367, 368**

Reading, good, 224

Receiver, telephone, **470**

Recessive characteristics, 509

Reclamation of swamps, 311

Recreation, 217, 400

Reflection, 164

Refrigerator, **92**

construction, 91

uses of, 92

value of, 91

Relative humidity, 290

Resistance, electrical, 209

Respiration, artificial, **59**

Retina, 177

Road, making, 410

Rocks, 265

changes in, 266

kinds of, 265

Ross, 13

Rowing, 440

Safety first, 158, 389, 394

of life and property, 394

Sailing, **441**

Sal ammoniac, **201**

Sanitation, bathroom, **101**

flush tank, **102**

garbage pails, 99, 107

plumbing, 100

Schools, 255, 395, 397

Science:

method of, 15

relation of discovery of cause of
 malaria, 13

study of, 12

use in daily life, 11, 15

use in school work, 17

use in straight thinking, 16

Score cards:

care of eyes, 183

climate and weather, 293

community care of food, 346

community water supply, 330

community; environment, 256

convenience and labor saving, 215

fire hazard survey of home, 160

heat in my home, 147

home and community gardens, 496

home score card, 40, 41

indoor recreations, 241

lighting my home, 172

outdoor recreations, 240

personal health habits, 121

protection against disease, 122

public sanitation, 369

pure food in home, 95

relation of water to economic life,
 315

safeguarding life and property, 406

transportation and communication,
 479

water in my home, 74

Screw, 194

Seasons, cause of, **276**

Segregation, Mendel's law of, **509, 510**

Septic tank, 104, **105**

Sewage, disposal of, 104, 320

city care of, 251

disposal into rivers, 319

septic tank, 104, **105**

Sewer systems, 104, 319, 320

Shadow, 163

Shears, **186**

Short circuit, danger from, 212

description of, 211

Signals, as means of communication,
 462

by ear, 464

by light, 463

Siphon, method of working, 101, 102

Skiing, **246**

Smothering, 155

Soap, use of, 72

washing powders, 73

- Soil, 482
 - air in, 483
 - effect of cultivation, 483
 - formation of organic, 260
 - harrowed and packed, 483
 - inorganic, 260
 - mineral materials in, 484
 - nitrogen from, 485
 - water in, 482
- Solar system, 234
- Solution, 72
- Sound, 219
- Spark, in gas engine, 432
- Spectrum, 179
- Speech, how we talk, 221
- Speed, change of, 191
- Sperm cell, 505
- Spontaneous combustion, 154
- Spores, 88, 110
- Springs and wells, 63
 - safe and deadly, 65
- Sprinkler, automatic, 392, 393
- Stability, of airplanes, 459
 - of boats, 439
- Stamens, 504
- Stars, 232
 - Big Dipper, 238
 - groups of, 238
 - North Star, 238
 - our relation to, 234
 - shooting, 239
- Steam engine, 415, 416, 417
- Steam heating, 142
- Steamboats, 441
- Stegomyia, 364
- Stone, 30
 - artificial, 31
 - granite quarry, 29
 - life of building, 30
- Storms, cyclonic, 281
 - effect of, 288
 - foretold by barometer, 280
 - how caused, 282
- Stoves, coal, 137
- Street lighting:
 - beauty of, 383
 - by electricity, 376
 - history of, 370
 - natural gas, 372
 - reasons for, 371
 - sources of, 371
- Streets,
 - cleaning of, 349, 350
- Stringed instruments, 223
- Submarine, 443
- Sun, 235
- Sunlight, 277
- Swamps, reclamation, 310, 311
- Teeth, 114, 115
- Telegraph, 465
 - working of, 466, 468
- Telephone, 468
 - receiver, 470
 - transmitter, 469
- Telewriter, 477
- Temperature, 129
 - kindling, 128, 129
 - measurement of, 127
 - relation to body, 128
 - relation to plant life, 263
 - relation to community life, 289
- Thermometer, 127
- Thermos bottle, 93
- Thunderstorms, 283
- Tonsils, 58
- Tornadoes, 283, 285
- Toxins, 113
- Toys, 226
- Tractors, 436
- Trade routes, 444
 - seasonal changes of, 445
- Traffic scenes in New York, 426
- Transatlantic flight, first, 455
- Transformers, 202
 - use of, 379, 380
- Translucent, 163
- Transmission, 433
- Transparent, 163
- Transportation:
 - by land, 408
 - by rail, 419
 - by water, 437
 - changes in, 409
 - through air, 449
 - use of rails in, 414
- Traps, 103, 104
- Trees, 306
- Triangle of life, 513
- Tuberculosis map, 25
- Tungsten light, 168, 169, 382
- Typhoid germs, 322, 323, 336
 - vaccine, 356
- Underclothes, 133
- Unit characters, 508, 509
- Universities, 397
- Vaccination, 113, 356
- Vacuum sweepers and cleaners, 205
- Variation, 503
- Veins, 98
- Vent pipe, 104
- Ventilation, need of, 54, 55
- Vines, climbing, 27
- Vitamins, 79
 - chart of, 81
- Vitreous humor, 177

Vocal cords, 219, **220**

Voice, 219

Volcanoes, 264

Volt, 209

Voltage, 209

Voltmeter, 209

Wastes:

body poisons, **115**

disposal of, 350

removal from body, 97, 98

removal from home, 99

Water:

as a land builder, **300**

as an underground solvent, **72**, 299

as an eroding agent, 267, **268**, **298**

composition of, 62, **126**

cycle of, **63**

hard, 72

impure, 65

lifted by air pressure, **69**

pure, 62, 318

purification, 73

rain, 62

relation to body, **297**

relation to climate, 287

relation to community welfare, 295

relation to power, 301

relation to soil, 297

soft, 72

Water holding power, 297, 299

Water power:

relation to community, 249, 305

utilization of, 302

what it is, 301

Water routes, presence of, 248

Water seal, 104

Water supply:

dangers of, **100**

Water supply:

drinking water, 318

effects of differences in, 307

gravity distribution of, **327**

of modern cities, **326**

problems of, 321

protection of, 327

river, 321

sources of, 318

Water transportation, 437

Waterways, canals as, **446**

inland, 447

Water wheels, 303, **304**

Watt's engine, 416

Waves, in radio, **474**

Wave lengths, 475

Weather, 246

and climate, 278

maps, **281**, **282**

relation of air pressure, 278

Weather maps, **281**, **282**

Weighing, 188

Wells:

artesian, **64**

driven, 66

pollution of, 65, 66, **100**

Wheels, on vehicles, 189

size of, 413

Windlass, **191**

Winds, 283

Wireless, 471

Wood, as building material, 28

Work, unit of, 189

Wright brothers, 454

Writing, sent by wire, 477

Yeasts, 87

used in bread making, 87

Yellow fever, 363

theory = sthng that may be true
something that has to be proved -
fact = something that has been proved.

Diameter 8000
25,000 around earth

Cause of:

Summer earth tips toward sun

Winter earth slants from sun

Chemical
Physical

Sound is the vibration
of the air.

Gneiss - stratified rock - depends
266 Color
stratified different layers.
sandstone

Marble is limestone that has
been heated to a high degree
slate is heated shale

closing leaves

